JUNE 8, 1959

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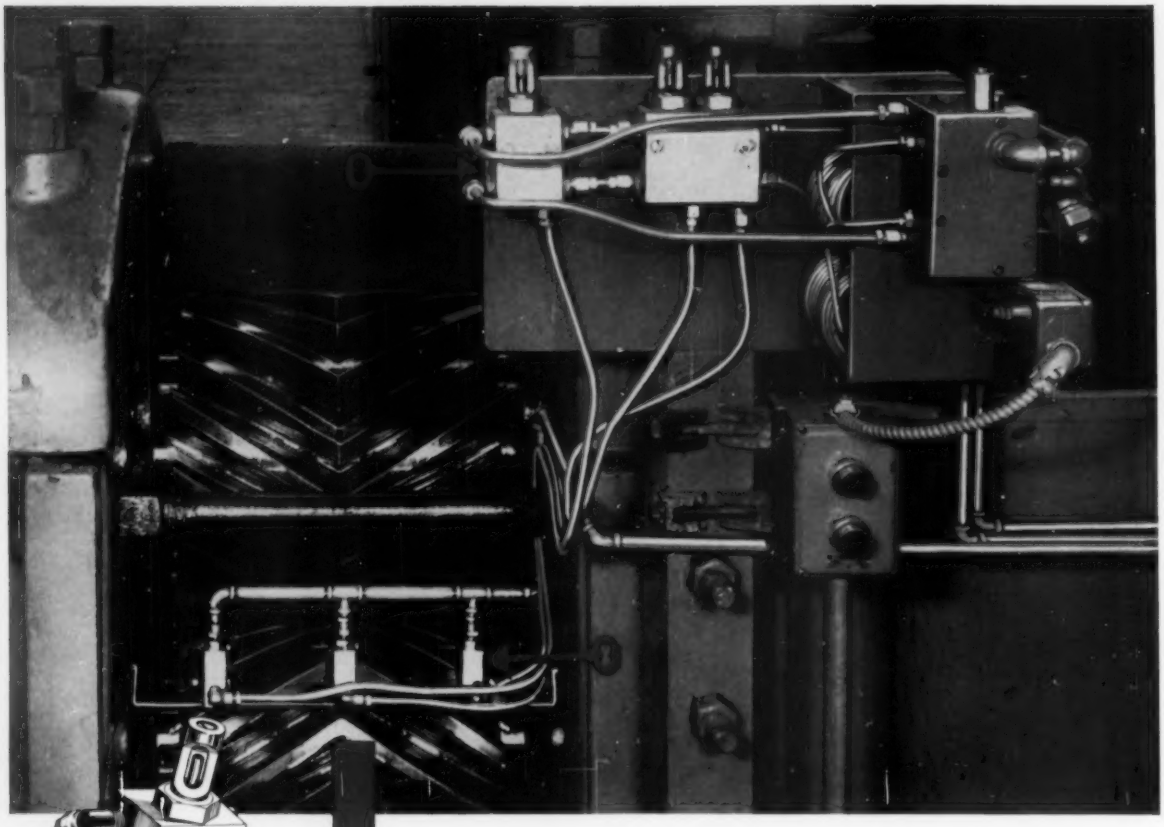
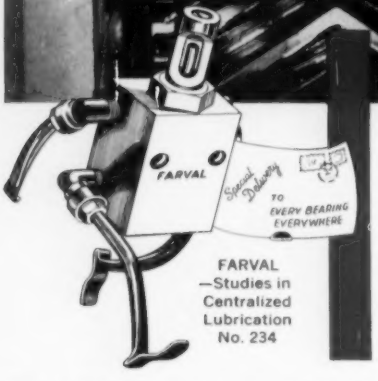
Product Engineering

McGRAW-HILL WEEKLY ... SIGN, RESEARCH AND DEVELOPMENT

RADAR nose smells out interceptor target — page 5





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No. 234

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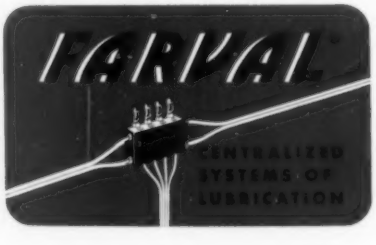

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SPHERICAL BEARING ROD ENDS

All seven of them . . . carry the weight and complete all linkages in the "Orbit Seven" Quarter midget Racer

The "Orbit Seven" was designed and is built by The Orbit Midget Mfg. Co., 400 Surf Ave., Stratford, Conn.

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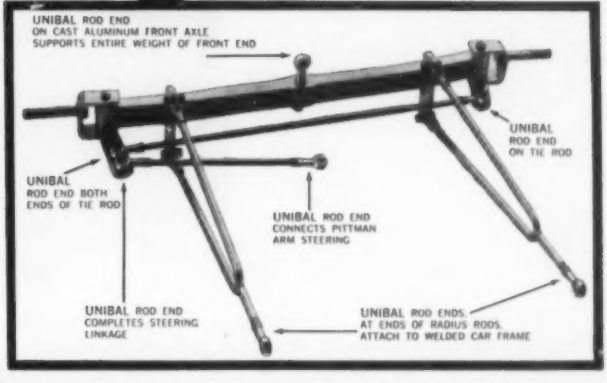
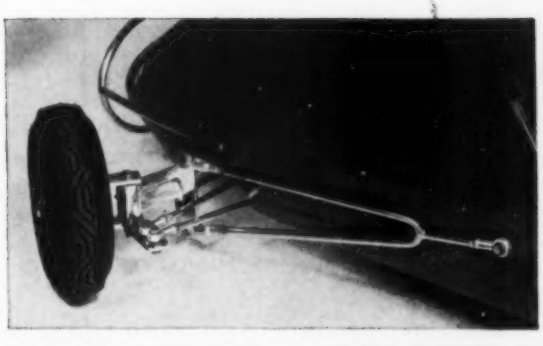
- **Minimizes the effects of vibration.**
- **Are more economical than specially made parts.**
- **Carry heavier loads.**
- **Correct mal-alignment in all directions.**
- **Are easy to assemble and help to reduce costs.**


UNIBAL ROD END ON CAST ALUMINUM FRONT AXLE SUPPORTS ENTIRE WEIGHT OF FRONT END
UNIBAL ROD END ON TIE ROD
UNIBAL ROD END BOTH ENDS OF TIE ROD
UNIBAL ROD END CONNECTS PITTMAN ARM STEERING
UNIBAL ROD END COMPLETES STEERING LINKAGE
UNIBAL ROD ENDS AT ENDS OF RADIUS RODS ATTACH TO WELDED CAR FRAME



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Product Engineering

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

DESIGN issue

June 8, 1959 Vol. 30, No. 23

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US RUBBER **PowerGrip** "TIMING" BELTS

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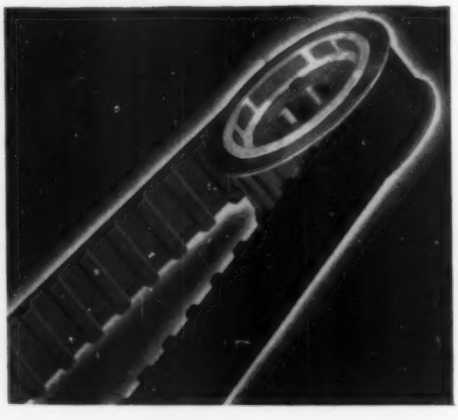

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Interesting to Note . . .

Eyes in the Dark

In November of 1940, the Italian fleet found itself being harassed by an unseen midnight marauder. British warships were able to track and sink two destroyers and three cruisers in the Ionian Sea without being observed by the Italian navy. Several months later, Max Ponzo, chief of Italy's Naval Intelligence reported, "One of our ships was sunk by a British surface vessel. Neither could see the other—and yet ours was hit and sunk." Obviously, the British had found some way to see in the dark—and not only at sea. During the battle of Britain, a "secret device" enabled the British to know when the "jerries" were coming. Then when the Nazis began flying at night, RAF pilots took an amazingly high toll of German planes. Americans were told in their newspapers that it was the heavy carrot diet that enabled British pilots to have catlike eyes. But scientists who had developed a Radio Detection and Ranging system, dubbed "radar," knew differently.

Although the credit for radar goes to the British, it was a pair of Americans who got on the trail first. In the Dec 1946 issue of *The Antioch Review*, William Gilman (now copy editor of PRODUCT ENGINEERING) described how Dr. Albert Taylor and Leo Young, of our Naval Research Laboratory in Washington, made the discovery. It was in 1922, when they found that a small moving object—a wooden ship on the Potomac—interfered with radio waves they were sending to each other across the river. Even when other Americans "bounced" radio waves to locate the ionosphere, our R & D wasn't alert to the implications. So England carried on.

The British government in 1936 gave Robert A. Watson-Watt a $20 million appropriation for establishing a coastal radar-warning network. Where the British considered radar a serious scientific achievement, we were still considering it a "tricky gadget."

There was never a more disastrous misunderstanding of radar's worth than that bleak 7th day of December 1941. Nineteen years after US scientists hit on the radar principle, 16 months after it saved England from air attack, an American soldier stationed in Hawaii, Private Lockard, was showing a buddy how radar worked. It was 7:02 Sunday morning when Lockard picked up a considerable number of planes heading toward Oahu from a direction of 3 degrees east of north. He first thought the machine was broken, but when he checked and double-checked, he realized it was

(CONTINUED ON PAGE 7)

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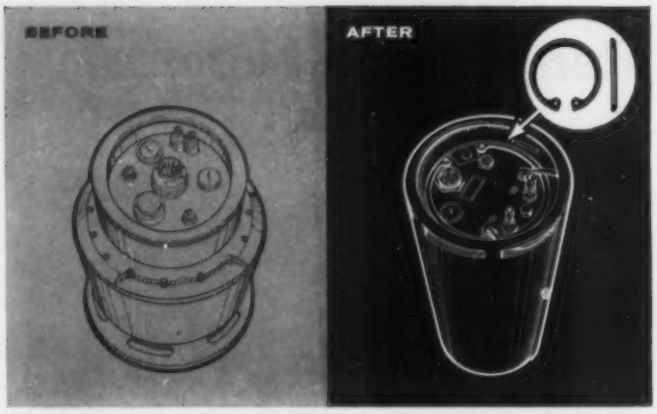
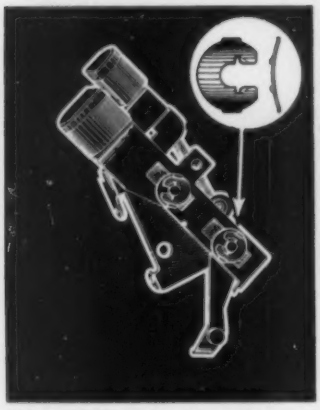
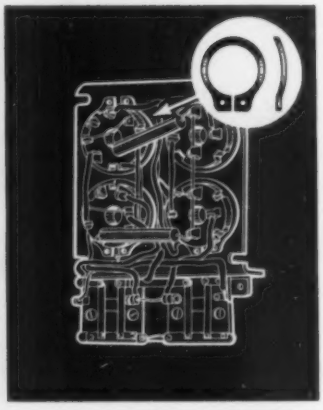


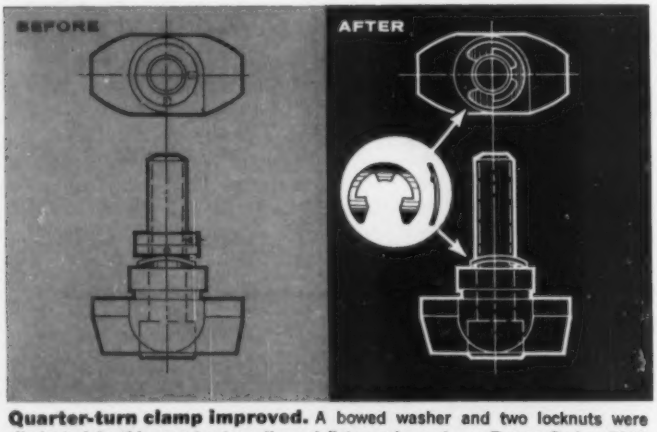
Pressure cover design simplified. Two axially assembled Truarc Series 5002 beveled rings eliminate 27 bolts, reduce machining and assembly time from 78 to 1½ hours and make possible drastic size and weight reductions. Rings retain two covers of a pressurized x-ray unit. **Savings: about $500 per unit.**



Parts eliminated in slide assembly. Two radially assembled Truarc Series 5139 Prong-Lock® Rings provide proper spring tension, eliminate looseness and wobble in this office calculator shift-slide. Original design called for a cut washer, spring washer, and cotter pin — all eliminated.



New way to install electron-tube sockets. Easy-to-apply Truarc Series 5101 bowed external rings lock tube sockets to chassis plate in this assembly. Bowed construction takes up tolerances of molded grooves, thickness of base. Individual sockets are removable for field service.



Quarter-turn clamp improved. A bowed washer and two locknuts were eliminated in this quarter-turn jig-and-fixture clamp by a Truarc Series 5131 bowed E-ring. The radially assembled ring holds the screw captive, provides required rotational drag between parts with sufficient tension to insure tight fit when the screw is first engaged. **Typical savings: $1.35/unit—assembly up 70%.**

Truarc rings for end-play take-up offer significant design advantages

A number of Truarc retaining rings are available to take up end-play or loose fit caused by accumulated tolerances and wear. The rings often eliminate spring washers, collars and set screws, nuts, bolts, rivets, cotter pins and other conventional fastening devices with outstanding cost savings in machining and assembly time.

Truarc retaining rings designed to deal with the end-play problem are of two general types: **bowed rings** for resilient end-play take-up and **beveled rings** for rigid end-play take-up.

Bowed retaining rings are widely used for preloading bearings, preventing vibration or oscillation in linkages, providing tension on adjusting screws. Of particular interest is the radially installed Truarc Prong-Lock® ring which locks securely to the shaft by means of two prongs. It provides exceptional thrust load capacity, may be used as a shoulder against rotating parts, and often eliminates springs, bowed washers and other tensioning devices.

In beveled rings for rigid end-play take-up, the groove-engaging edge is beveled at 15°. There is a corresponding bevel on the load-bearing groove wall. To take up end-play, the ring acts as a wedge between the outer groove wall and the part being retained.

These are just a few of the 50 functionally different types of Truarc retaining rings. They come in up to 97 standard sizes, six metal specifications, 13 different finishes. The entire line as well as accessory assembly tools, grooving tools, and over 70 typical applications are shown in the new catalog RR 10-58. Write for your copy today. And remember Waldes Truarc engineers are always ready to work with you on your specific projects. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N.Y.

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Waldes Kohinoor, Inc., Long Island City 1, N.Y.

TRUARC RETAINING RINGS...THE ENGINEERED FASTENING METHOD FOR REDUCING MATERIAL, MACHINING AND ASSEMBLY COSTS

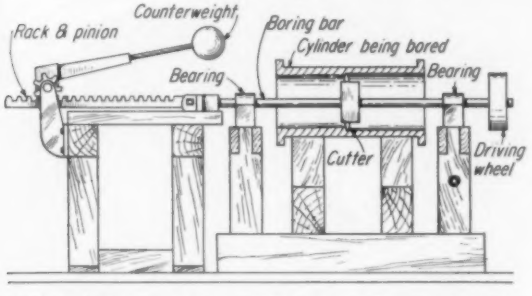
definitely working properly. He reported his find to his superior officer—the planes were then 132 miles away. By the time Lockard's lieutenant had been awakened and told what radar had detected . . . and had sent the private away and gone back to sleep . . . there was still sufficient time to act. The rest of the story is tragic history.

Radar finally got a top priority rating in the US and the results are amazing. Now it's used on highways to detect speeders and by astronomers to reach out to distant planets. Our cover shows a common military use—radar in the nose section of a Navy-Douglas F4D Skyray enables it to fly regardless of weather conditions.

Just What Watt Wanted

Watt's steam engine gave tremendous impetus to the Industrial Revolution two centuries ago, but before building his engine he needed a machine to accurately bore its cylinders. He needed a boring mill. Watt took his problem to John Wilkinson, a foundryman and ironmaster in Bersham, England. Could Wilkinson develop such a machine? (Cannon reamers were available but not accurate enough.) It took many trials and errors, but in 1775 Wilkinson developed the world's first boring mill and Watt had his engine.

A full-scale reproduction of Wilkinson's mill, made from the original drawings, went on display last month in the DoALL Co's new Hall of Progress in Des Plaines, Ill. The mill, shown below, consists of a hallow, cylindrical bar, 10 in. dia, supported in a bearing at each end. Mounted on the bar and rotating with it is a cutter head



which is fed through the cylinder by a long rod passing down the hollow core of the boring bar. One end of the rod connects with the cutter through a longitudinal slot in the boring bar. Other end of the rod is attached to a rack, and prevented from rotating by a cross bar resting on two wooden beams. The rod is advanced by means of a weighted lever acting through a gear pinion engaging the rack. Though this did the job, it was pretty crude compared with modern mechanisms used in automatic machinery, such as the three-gear drive described on page 80.

Hold Everything!

Fastenings for many purposes can be found in the rundown beginning on page 91. Some of those described are new; others, in principle, date back to 225 BC when Archimedes invented the screw. The Greek mathematician used the screw not as a fastening but as a force for moving, when he first applied the concept of the helix or spiral for lifting water from one level to another. Archimedes' water screw was called a cochlea, Greek for snail, doubtless because of its resemblance to the shape of a snail's shell. Romans later took the word and applied it to their wine and oil presses which utilized an upright screw turned by a lever.

The Romans also were the first to use the Archimedean screw as a fastener. Jewelers wanted a new way to hold the ends of necklaces and bracelets secure. A screw device was the answer, but it wasn't easy to make. The craftsman had to take a cylindrical metal rod and wind two pieces of wire side by side to give the desired pitch. After fastening the ends of one wire by brazing or soldering, the second wire was unwound, leaving a rather crude but effective screw. It had some semblance of uniformity in pitch and lead, and with its tapered body and blunt point served very well for many years. Surgeons also used screws of this type for dilating openings in the body.

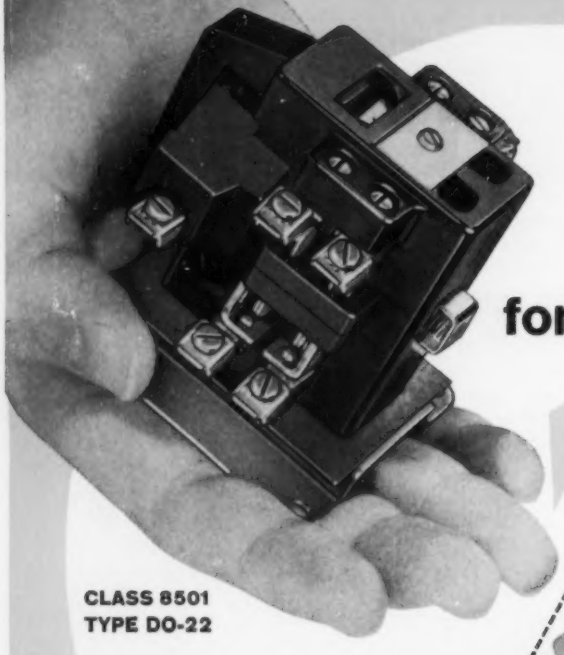
Where Amateurs Lead Pros

It's strange that in the field of photography, so many recent innovations have come from people who were neither scientists nor professional photographers. The big breakthrough in color photography was the result of spare-time dabbling by two professional musicians—Mannes and Godowsky; the one-minute developer was conceived by a Harvard student, Edwin Land; and xerography (p 82), the method of using powder and static electricity to reproduce images at high speed, was invented by a 32-year-old attorney.

Although Chester Carlson, xerography's inventor, had a technical education, the depression forced him to leave Bell Laboratories in 1933 and switch to law. He received his law degree by attending night school and in 1934 joined the patent department of P R Mallory & Co. But research still intrigued him. Working in his home darkroom Carlson experimented with an idea for reproducing photos by using static electricity. He rubbed a sulfur-coated plate with a cloth to charge it. Then he placed a transparent ruler with black markings over the plate and exposed both to light for 10 seconds. He turned off the light, removed the ruler, and sprinkled lycopodium powder on the plate. The electrostatic force held the powder to the exposed portions, and when he blew off the excess lycopodium, the tiny powder particles that remained gave him a perfect reproduction. Xerography, Greek for "dry writing," had been invented. In 1949, Battelle Memorial Institute agreed to conduct further research; two years later, when the experiments proved successful, the Haloid Co became interested. It introduced the first commercial machine in 1951.

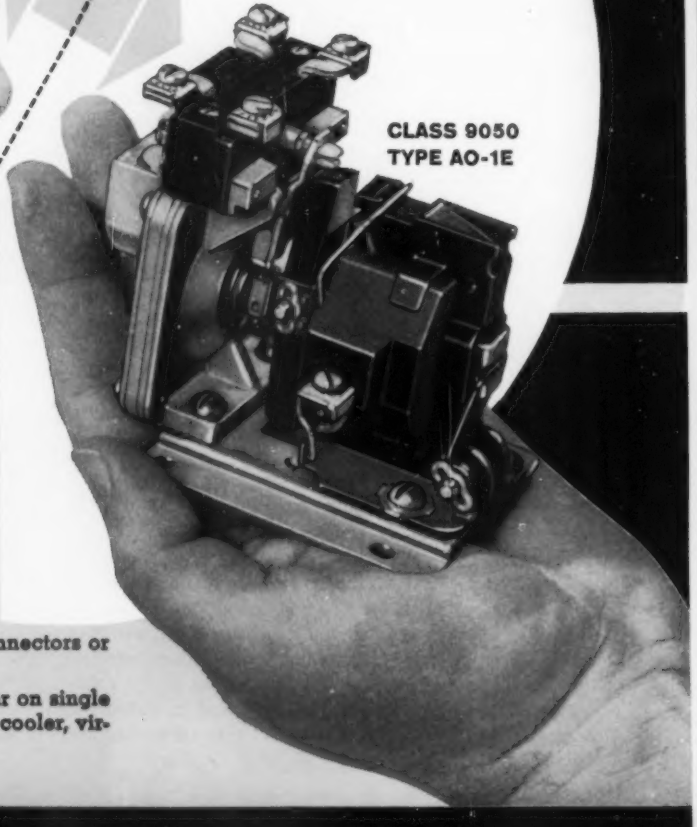
—Benedict A Leerburger Jr

Smaller Control Panels with



CLASS 8501
TYPE DO-22

These 2 UNITS are the basis for a Complete System of relays



CLASS 9050
TYPE AO-1E

Here's why designers and users alike prefer Square D...

Complete selection • Relays available for both AC and DC systems—with up to 10 contacts—in both electrically and mechanically held forms. Timing relays with intervals from 0.2 second to 3.0 minutes—also in AC and DC versions.

Require less panel space • Relays are only 3" wide, range in height from 3¼" to 5". Timers are just 2⅝" x 4⅜6" or 2½" x 7²½₂". Mechanically held relays require no extra panel space.

No mounting problems • All Type D relays and Type A timers have identical mounting hole dimensions.

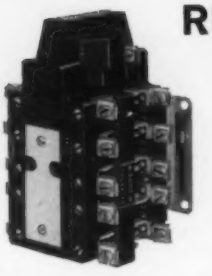
Easy wiring • Choose either pressure wire connectors or slip-on connectors for all terminals.

Long life • Balanced construction reduces wear on single moving part. Epoxy-resin molded coil operates cooler, virtually eliminates coil burnout.

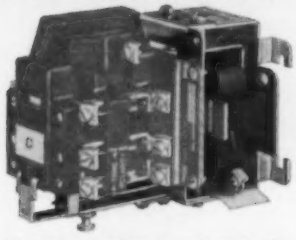
SQUARE D COMPANY

Square D "SYSTEM-DESIGNED" Relays

RELAYS FOR EVERY JOB



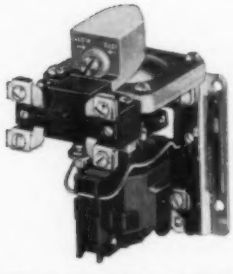
Square D Type D relays available with up to 10 contacts



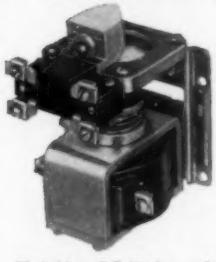
Easy-to-use attachment converts any Type D relay to mechanically held with no increase in panel space

DC relays have mounting dimensions and contact arrangements identical to AC relays

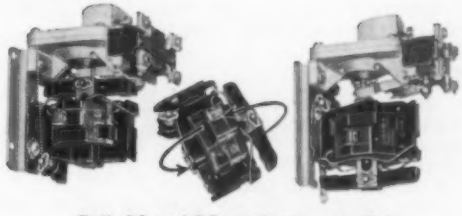
WIDE CHOICE OF TIMERS



Timing relays have same mounting dimensions as Type D relays

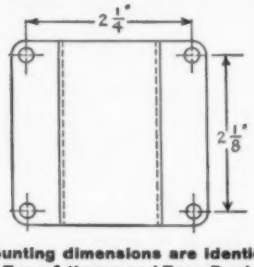


Matching DC timing relays

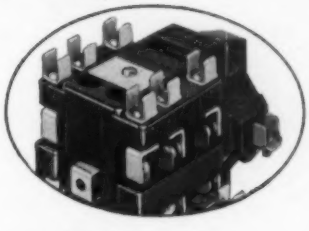


Both AC and DC versions convertible from on-delay to off-delay, using only a screwdriver

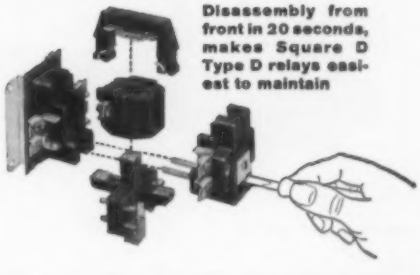
FAMILY FEATURES SIMPLIFY DESIGN PROBLEMS



Mounting dimensions are identical for Type A timers and Type D relays



Slip-on connectors for all terminals available



Disassembly from front in 20 seconds, makes Square D Type D relays easiest to maintain

Write for full details • Ask for Bulletin D, Square D Company, 4041 N. Richards St., Milwaukee 12, Wis.

Square D offers the broadest line of relays, starters and accessories for all types of control systems

Ask your Square D Field Engineer about the new ILO program

New line of precision sub-miniature DC motors with optional speed governors and gear trains

The new Cramer Type 810 sub-miniature DC motors have been perfected to meet the growing need for a unit combining very light weight with high efficiency and accurate speed control, in a standard ⅞" cylindrical frame. These motors are available with or without speed governors and gear trains, offering the user an exceptionally wide choice to meet most application needs.

Operation

Type 810 motors, without the addition of a speed governor, have a nearly linear relationship of speed to applied voltage, and of speed to load or torque. Precise control of armature winding permits an unlimited selection of operating characteristics in terms of these three basic factors. In the ungoverned versions, accurate speed control can easily be obtained by varying the applied voltage below the rated maximum. Efficiency remains high over virtually the entire operating range.

Speed Governors

These are of the internal, vibrating-reed type, regulating motor speed on the basis of average power supplied to the armature circuit, and require no separate brushes and no external arc-suppression network. The effective degree of speed regulation will depend on several factors in each instance. In general, however, under a combination of load and voltage variation the speed will not vary more than ±2% with a ±20% voltage change and a ±50% load change from nominal. The speed at which the unit regulates is set accurately at the factory, to meet the user's specified requirements.

Gear Trains

The addition of a gear train provides a wide range of output shaft speed reductions, with a corresponding increase of available output torque to a maximum continuous load of 50 ounce-inches. Seventy-three different gear ratios are available, from 48:1 to 13,000:1.

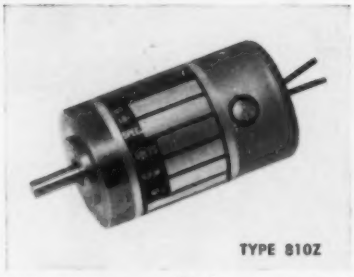
Features

OPERATING VOLTAGE — any specified DC voltage from 3 to 30 volts. Armature is wound for the specified voltage, load and speed.

OUTPUT SPEEDS — no-load speeds from 5,000 to 20,000 rpm, with different armature windings as required by the application.

SPEED REGULATION (governed) — ±2% for ±20% voltage change and ±50% load change from nominal.

ARMATURE — precision ground, Mylar insulated, lacquered and baked.



TYPE 810Z

COMMUTATOR — molded type, ground and polished.

BRUSHES — cartridge type for easy replacement, with springs soldered to brushes and holders to insure positive electrical connection.

MAGNET — Alnico VI, with machined pole pieces.

BEARINGS — precision ball bearings, life lubricated to meet the specific requirements of the application.

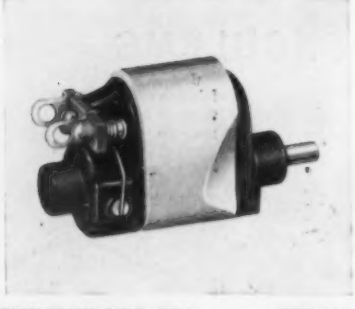
SHAFT — type 416 stainless steel.

GEAR TRAINS — precision-cut 120 pitch, integrally hobbed with pinions to minimize eccentricity.

HOUSINGS — anodized aluminum.

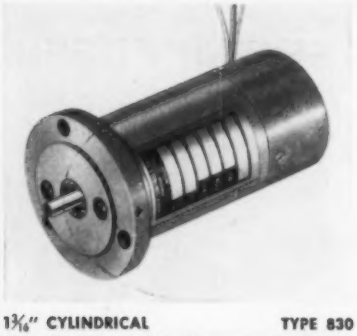
WEIGHTS — from 2.1 oz. to 4.7 oz., depending on choice of speed governor and gear trains.

THREE OTHER BASIC DC MOTORS OF BROAD USEFULNESS



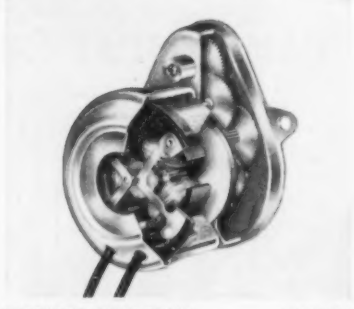
OPEN-FRAME MINIATURE **TYPE 820**

Type 820 resembles Type 810 (above) in its basic operating characteristics, and is even smaller in size and lighter in weight. Available only in standard form, without speed governor or gear train, it operates on any specified DC voltage from 3 to 30 volts. No-load output speeds range from 5,000 to 30,000 rpm, depending on armature winding. Special magnet design permits an extremely light weight of only 1.4 oz. DETAILS IN BULLETIN PB-820.



1 3/16" CYLINDRICAL **TYPE 830**

Type 830 is a slightly larger version of the basic ⅞" motor (Type 810), permitting larger load capacity at equivalent speeds, and is offered with or without speed governors. Armatures are wound for any specified voltage from 3 to 30 volts DC. No-load output speeds range from 5,000 to 20,000 rpm, depending on winding. Weights of ungoverned motor, approx. 8 oz.; governed, about 8.25 oz. Alternate mounting arrangements are available. DETAILS IN BULLETIN PB-830.



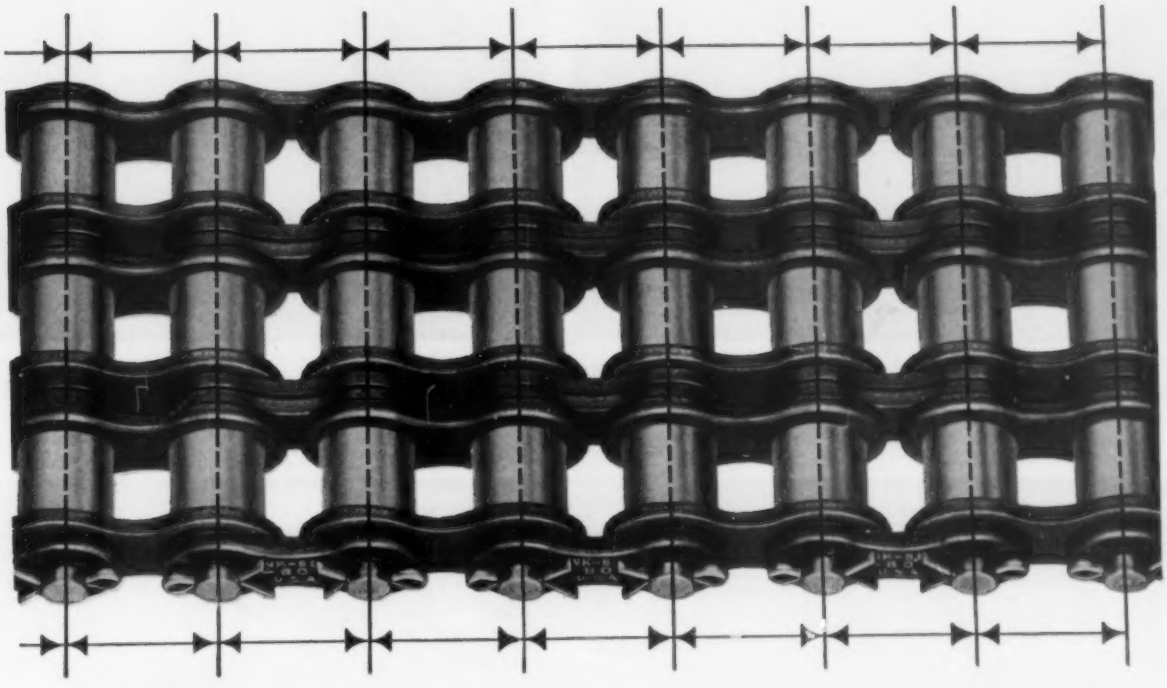
ELLIPTICAL GEAR TRAIN **TYPE 800**

Offering an unusually wide range of output speeds, with high torque, low current drain, and excellent speed characteristics. Output speeds from 2 rpd to 900 rpm, with torque as high as 30 oz-in. Operating voltage may be any specified value from 3 to 30v DC. Type 800 is also available without gear train, for output speeds from 960 to 3,000 rpm. Speed regulation is within ±10%, current drain as low as 30 ma. DETAILS IN BULLETIN PB-800.

CRAMER CONTROLS

CORPORATION

Box 7, Centerbrook, Connecticut



Equal length... equal strength

How pre-stressing ensures uniform load distribution of multiple-width LINK-BELT roller chain

Pre-stressing is one of the reasons why Link-Belt multiple-width precision steel roller chains easily handle the grueling loads common on today's drives. It seats and cold works the chain joint parts, assuring equal load distribution across the chain, minimum initial elongation, increased fatigue life.

Pre-stressing is just one of many "extras" that contribute to the *greater dynamic strength* of Link-Belt roller chain. Others include: close heat-treat control, lock-type bushings, shot-peened rollers, pitch-hole preparation. For details see Book 2657.

PRE-STRESSING MACHINE provides the pull that "sets" the parts of Link-Belt multiple-width roller chain. Besides assuring uniform load distribution, pre-stressing eliminates application difficulties on fixed center drives because the chain leaves the factory at precise operational length.

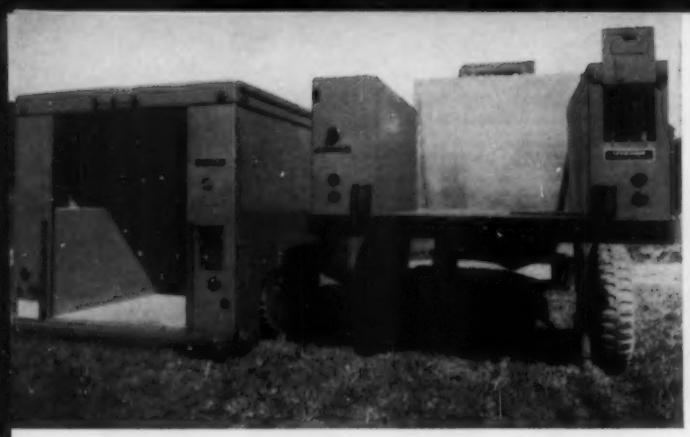
LINK-BELT

ROLLER CHAINS AND SPROCKETS

BOOK 2657 has 154 pages of roller chain data. Contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your classified phone directory.)

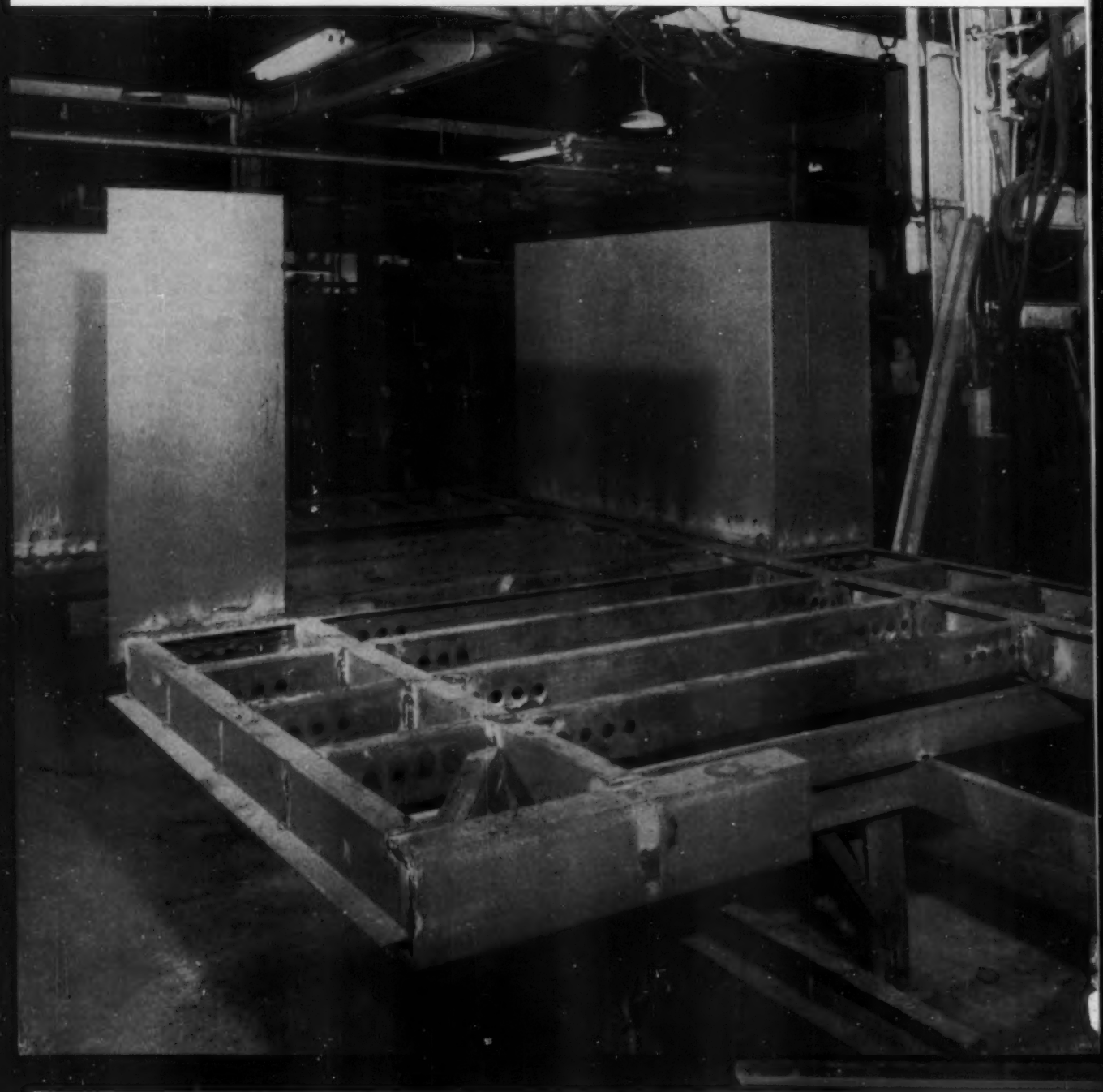
15,078

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.



The Thompson Level-Loder raises and lowers to any height from curb side to 4½ feet. Hydraulic cylinders lift the body up and down in a vertical guide mounted on the truck cab. Thompson Trailer Corp., Pikesville, Maryland, a subsidiary of General American Transportation Corp., Chicago, introduced the new design.

It tilts . .



. it leans . . . . . it hunches up and down

Unique truck built lighter, stronger with USS COR-TEN Steel

Here's a truck body that acts like an elevator. With front wheel drive, it has no rear axle or drive shaft. Hydraulic cylinders tilt it forward, backward, sideways, and raise it up and down to any height from curb level to 4½ feet. This cuts loading time as much as 75% and makes unloading up to five times faster.

Because the main stress of the lift is concentrated at the wheel box housings, they have to be as strong as possible. And because the truck body is lifted along with the payload, the body has to be as light as possible. The entire body, including the wheel housings, was built with USS COR-TEN High-Strength Low-Alloy Steel because this grade meets the demands of both lightness and high strength. COR-TEN Steel's 50% higher yield point means it can be used in thinner and lighter gages, reducing weight as much as ⅓ with no sacrifice in strength. And it has high resistance to abrasion, atmospheric corrosion, impact and fatigue.

U. S. Steel produces three brands of High Strength Steel—COR-TEN, TRI-TEN, and MAN-TEN. Each has characteristics that make it ideal for special design applications. For complete information about these "steels that do more", write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa. *USS, COR-TEN, TRI-TEN and MAN-TEN are registered trademarks*

USS

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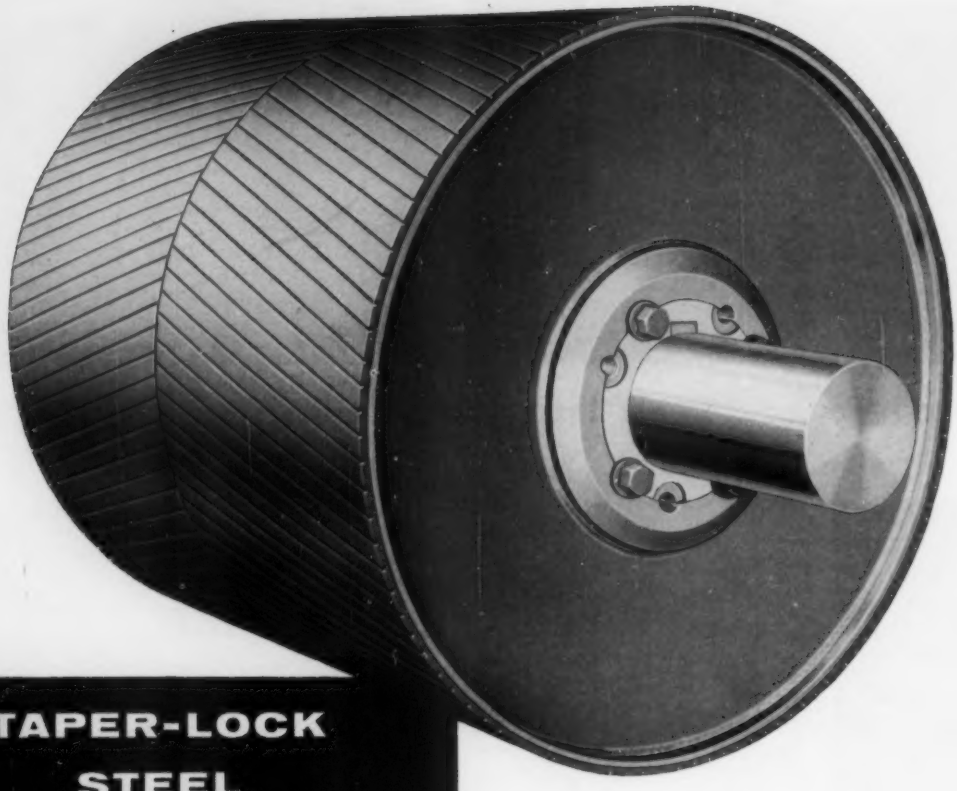
American Steel & Wire—Cleveland
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel



TAPER-LOCK STEEL CONVEYOR PULLEYS

Maximum strength with minimum weight...

Unmatched holding power on the shaft...

New mounting simplicity.

The rims, discs and hubs of these modern conveyor pulleys are *steel*—and they are fused together into jointless drum construction for (1) maximum strength with minimum weight, (2) exclusion of dirt, water, steam, (3) terrific shock resistance.

With the patented Dodge Back-up Bar, welds of full rim thickness are achieved—and the ultimate in strength is assured by submerged arc process welds.

Taper-Lock Steel Conveyor Pulleys *hold*. Taper-Lock provides the equivalent of a shrunk-on fit—there is no "walking" on the shaft. Mounting and demounting are simple. Pulley and bushings mount as a unit. Alignment is easy. And the tapered bushing is wedged into place merely by turning the mounting screws. It is "unlocked" by using the mounting screws as jack screws.

Available in diameters from 6 inches to 8 feet—all face widths. Standard or special rubber lagging available. Ask your local Dodge Distributor—or write us for bulletin.

DODGE MANUFACTURING CORPORATION, 1200 Union, Mishawaka, Ind.

97 Taper-Lock Steel Conveyor Pulleys are used in this famous conveyor system engineered, manufactured and erected by Hewitt-Robins, Inc., at the Southern Pacific's causeway construction across the Great Salt Lake.

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

THE ONES THAT WILL LAST (and last, and last!)? THOSE MADE OF WEIRKOTE® ZINC-COATED STEEL!

Laboratory salt-spray tests prove it. Leading manufacturers prove it. Experience proves it. Primary window frames and storm and screen frames of Weirkote zinc-coated steel last and last and last—literally shrug off the elements!

Weirkote will not give in to corrosion invasion because its zinc coat clings tightly to its steel surface year after year. Reason? Zinc and steel are actually integrated by Weirkote's continuous process.

This extra protection pays off when it comes to fabricating Weirkote, too. You can crimp it, twist it, torture it—work it to the limits of the steel itself—without chipping or flaking its surface. And this pays off in your pocketbook: No more costly rejects, and coating after fabrication can be eliminated.

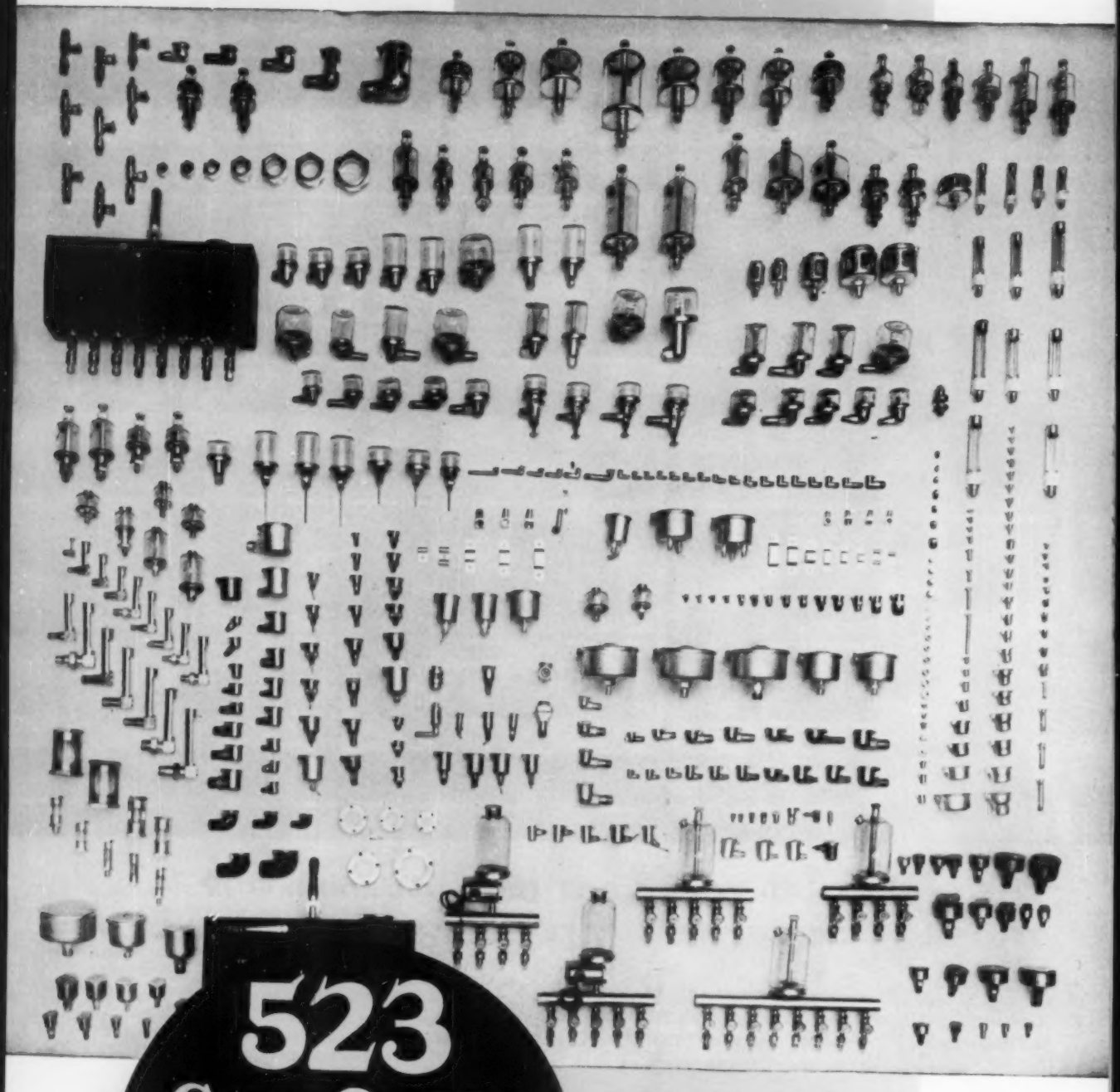
Whether you're talking profit or product, there's a lot to be said for Weirkote zinc-coated steel. Write today for a free booklet that tells all about it. Weirton Steel Company, Dept. D-14 Weirton, West Virginia.

WEIRTON STEEL COMPANY

WEIRTON, WEST VIRGINIA

a division of

NATIONAL STEEL CORPORATION



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Largest selection available anywhere. You save time and money, because the one you want is always right in stock. Send for complete Catalog.

Specialists in Lubricating Devices and Shaft Seals for Almost Half-A-Century

GITS BROS. MFG. CO.

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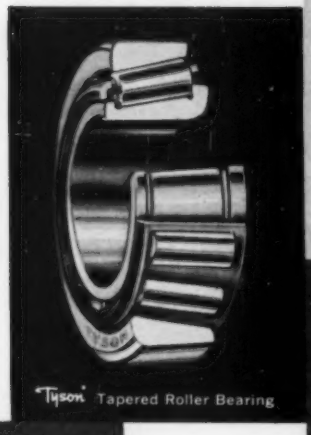
Spherical Roller Bearing



"Tyson" Tapered Roller Bearing

Spherical Roller Thrust Bearing

Single Row
Deep Groove Bearing

Cylindrical
Roller Bearing

Angular
Contact Bearing

When can a standard bearing do a "special" job?

Suppose you need a high speed bearing to support either heavy thrust load or thrust load combined with radial load. It is almost a certainty that SKF angular contact ball bearings will do the job.

SKF bearings of this type are produced in bore sizes ranging from 3/4" to just over 7". They lend themselves to all sorts of mountings. For example, you can mount them in pairs either face-to-face or back-to-back where axial rigidity and high radial capacity are needed. Or you can mount two or more bearings in tandem, where a particularly high thrust capacity is required.

Yet this is a standard SKF bearing, promptly available in over 80 sizes of single- and double-row types.

Almost every SKF bearing can do "special" jobs for you. Why not find out how they'd be more efficient and economical? Call any one of the twenty-five sales offices.

5924

Spherical, Cylindrical, Ball, and "Tyson" Tapered Roller Bearings

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

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CIRCLE 114 READER SERVICE CARD 17

HOW THE ENGINEERING SERVICES OF

Central Foundry

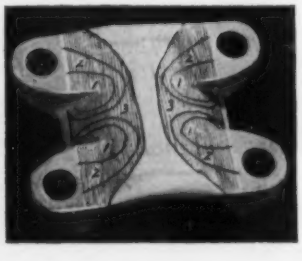
help you design better castings at lower cost

Many new developments here at Central Foundry have broadened the field of application for castings and have given design engineers greater latitude. To assist you in exploiting these new methods and materials to fullest advantage, each of our engineering departments—design, experimental, process and metallurgy—is at your disposal. Central Foundry is also using a number of testing techniques such as stress analysis, cobalt radiography and sonic testing, that have proven invaluable in lowering the cost and improving the quality of castings. These procedures help us to determine the best design and method of producing a casting, either by the green sand method or the shell mold process, and the best material for the casting, either grey iron, malleable iron or ArmaSteel.

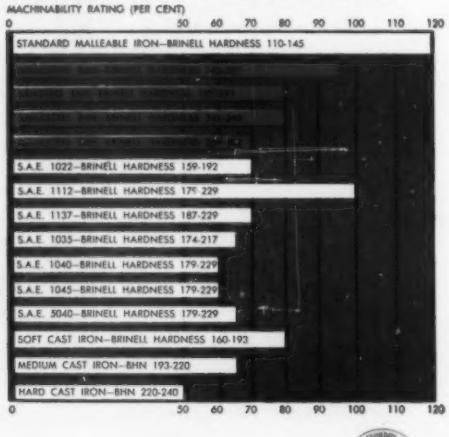
Central Foundry has the capacity to deliver, on schedule, quality castings in production quantities.

STRESS ANALYSIS FOR IMPROVED DESIGN

An important part of our engineering services is the stress analysis laboratory. Stress analysis discovers the amount of stress on a part due to its service function and is an important aid in determining and improving the strength of a part. Improved casting design can be accomplished through the use of stress-analysis by more effectively distributing the metal in the part. The U-bolt anchor plate shown here is a case in point. Our customer was experiencing failures in this part and asked us to see what we could do to solve the problem. Using stress analysis the part was completely redesigned for maximum efficiency. The redesigned part is 35% stronger, 42% lighter and less costly.



EXCELLENT MACHINABILITY FOR INCREASED PRODUCTION



CENTRAL FOUNDRY DIVISION

REDESIGN FOR STRENGTH

This is a rear spring clip pad that was converted to a casting with the help of stress analysis. The clip pad supports the shock absorber arm and clamps the spring to the rear axle of an automobile. When produced as a stamping, this part weighed 4-1/4 pounds. However, when designed as an ArmaSteel casting, weight was reduced to 2-9/10 pounds. Most important, based on comparative stress analysis tests, the casting is *30% stronger* than the stamping. (In addition, the holes are produced by the foundry, making it unnecessary for the customer to punch them.) This conversion from a stamping to a casting resulted not only in increased strength, but in substantial cost savings, as well.

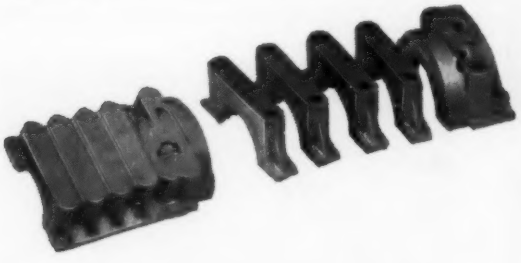
REDESIGN FOR IMPROVED PRODUCT AND ECONOMY

Many of our customers have found that redesigning a product to be made as an ArmaSteel casting rather than as a fabrication, forging or stamping, has resulted in a better part at less cost. The fabricated design of a rear wheel truck hub at the left consists of a forged base with a steel plate welded in place to form the smaller flange. The casting on the right, designed jointly by the customer and our engineers, is of single piece construction, is lighter, stronger and less costly than the fabricated design and eliminates the fitting and welding of the small flange.

FABRICATED DESIGN ARMASTEEL CASTING

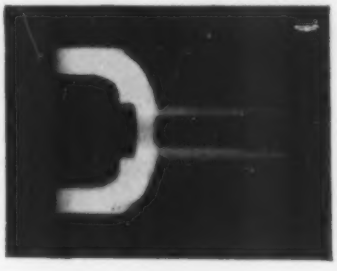
PROCESS ENGINEERING FOR LOWER COST

Our process engineers are continually looking for ways to more economically produce castings, thus lowering the finished-product cost. Shown here is a single casting that combines 5 bearing caps used on a V-8 engine. The casting is almost completely machined as a single piece, and the parts are then separated in a final operation. Substantial savings are realized in both casting and machining costs.



COBALT RADIOGRAPHY FOR ASSURED QUALITY

Radiography, by means of Cobalt 60, has drastically reduced the time required to check castings and is an important aid in obtaining the best possible casting quality. In an effort to eliminate a machining operation on the universal joint yoke shown here, a design change was made in the tube section of the part. When sample castings of the new design were checked radiographically, it was immediately apparent that the design was unsatisfactory since it caused acute metal feeding problems. By redesigning and further checking by radiography, Central Foundry was able to produce, in the shortest possible time, a lighter casting which required less machining in our customer's plant.

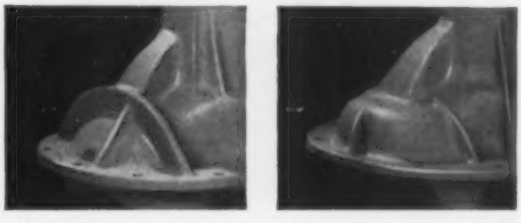


SHELL MOLDING FOR GREATER ACCURACY

Shell molding, a relatively new process of making castings, is now being employed extensively for fast, simple production of complicated castings, such as those requiring narrow, accurate passages and cross sections. It is practically impossible to produce certain parts in any other way without prohibitive costs; this is especially true of ferrous metals. Complicated parts like the manual control valve body shown here, a part of the automatic transmission of a military vehicle, are readily cast in grey iron when the shell process is utilized. The part had been considered as an aluminum die casting, but was thought unsatisfactory because of adverse expansion and wear characteristics. In this case, meeting the requirements for very close tolerances on the thickness and location of ports was made possible by the shell molding process.

REDESIGN FOR WEIGHT REDUCTION

Vehicle weight reduction is a matter of increasing importance to design engineers . . . and more and more existing parts are being converted from a low or medium to a high strength ferrous material such as ArmaSteel. On the left is a grey iron differential carrier currently used in an automobile. By taking advantage of the superior physical properties of ArmaSteel, it was possible to design the part on the right which is *five pounds lighter*. The modulus of elasticity of ArmaSteel is approximately 60% greater (the tensile strength about twice as great) than the grey iron material.



90

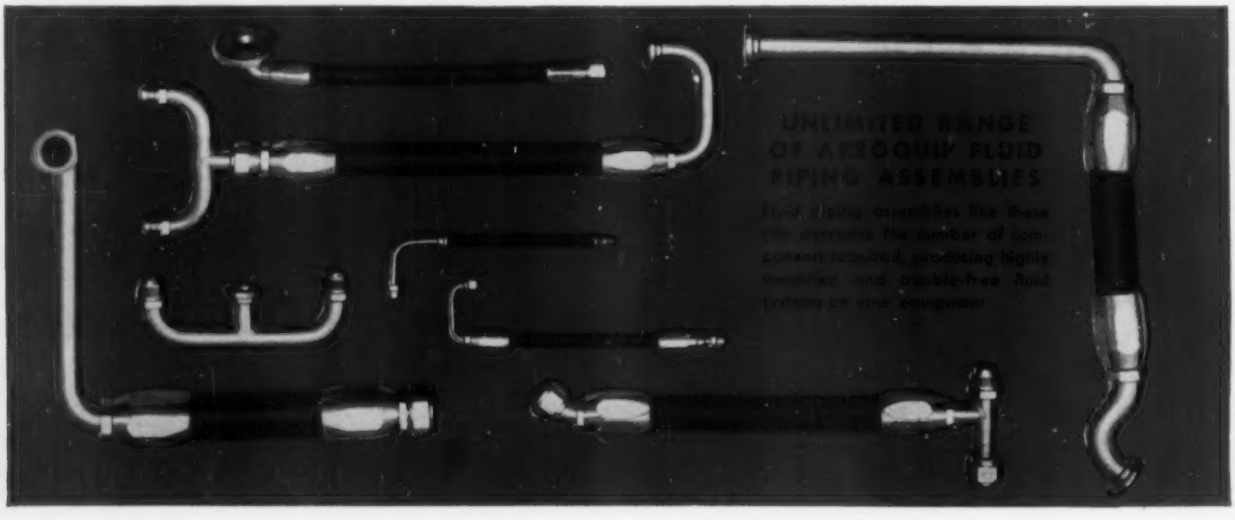
GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 10

Here's How Aeroquip Assists Equipment

Highly qualified Aeroquip sales engineers furnish design assistance right in your engineering department. In addition, your Aeroquip sales engineer is always on call when you need him.

Aeroquip's complete Industrial Catalog is probably on file in your engineering department library. Between printings it is supplemented with Industrial Engineering Bulletins on new and improved products.

The Aeroquip Catalog and IEB's are designed to provide the engineering data necessary to allow the draftsman to incorporate standard Aeroquip products and engineering drawings. Where a special item is designed to overcome a problem, your sales engineer will supply you with engineering standard sheets for this purpose.



Manufacturers in Fluid System Design

FLUID PIPING ENGINEERING SERVICE THAT STARTS RIGHT IN YOUR PLANT ASSURES MAXIMUM RESULTS

DESIGN
- PROTOTYPE
- PRODUCTION
- FIELD SERVICE
- SERVICE PARTS

Now you can get the full benefit of Aeroquip's outstanding fluid piping experience with engineering service that starts right in your own plant. Highly skilled teams of Aeroquip specialists have already helped many major equipment manufacturers develop and simplify the design of fluid systems needed to assure dependable, trouble-free service in the field.

Past experience proves that best results are obtained when Aeroquip engineers work closely with your engineers at the inception of the project.

This design assistance is only part of Aeroquip's complete OEM service program. Backed by the most complete line of fluid piping products, Aeroquip engineers follow up design recommendations with mockups of systems tested under actual operating conditions. Even production line service is provided by Aeroquip personnel who check fluid piping assemblies for correct fit and proper installation. Further assistance includes actual participation in setting up your service parts program on these fluid piping products.

And Aeroquip accepts full responsibility for fluid piping performance, even to the extent of providing field service on your equipment when it is in the field.

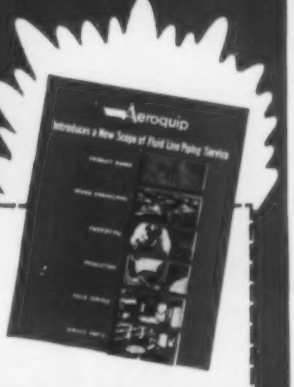
If you would like more information on this start-to-finish service, fill in and mail the coupon below.

Aeroquip sales engineers are expert in installation, routing and specifying products so as to produce efficient low cost installations. Many field service problems are avoided at the model stage.

And Aeroquip service on your new products in the field is supplied by service engineers who are available to assist your field and service parts personnel if unforeseen problems arise.

Aeroquip
REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN



Special Literature Available

Aeroquip Corporation, Jackson, Michigan

☐ Please send me a copy of Bulletin 614 explaining your complete service of fluid system design and performance.

☐ Please have an Aeroquip Sales Engineer call on me to discuss this service.

PE-6

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

What a build!

... solid state components in New Fenwal Temperature Controller combine precision with extra reliability

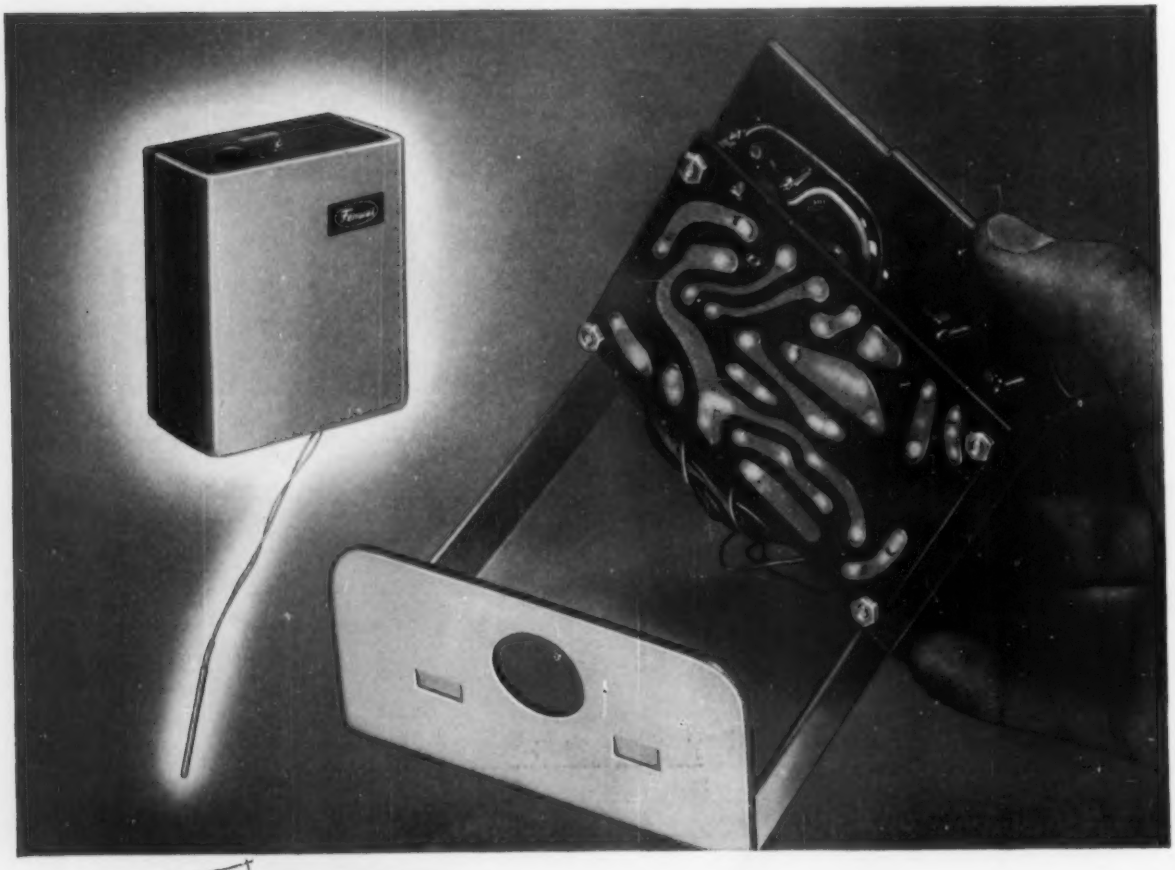
Here's a new, low-cost temperature controller that's really built "solid": thermistor sensing element, printed circuit, transistors. *No wonder the Fenwal 535 Temperature Controller provides high precision, trouble-free operation and long life!*

The Model 535's solid state components pay off in simplicity and dependability. The thermistor sensor mounts up to hundreds of feet from the controller using uncompensated electric wiring; has virtually limitless life; feeds into a rugged transistor amplifier. *No moving parts . . . nothing to wear out!*

The Model 535 is the latest advance in the low-cost line of Fenwal Temperature Controllers specifically developed to fully exploit the advantages ... rapid response, compact size, reliability . . . of solid state components. *And Fenwal, alone, has integrated production of both controllers and thermistors.*

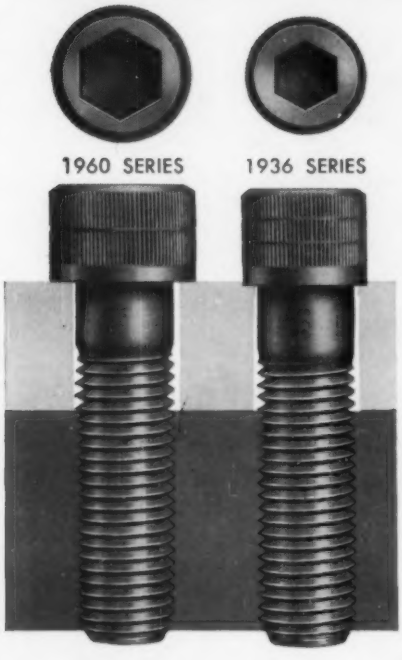
Use the Fenwal Model 535 Controller for fast response and close control of temperatures from −25°F to +600°F in plastics, packaging, or other critical applications. Get full details from a Fenwal Sales Engineer or write for catalog. Fenwal Incorporated, 26 Pleasant Street, Ashland, Mass.

Single point Model 535 Fenwal Temperature Controller has 2°F setting accuracy and sensitive operating differentials from 0.4°F to 1.2°F. Current capacity: 5 amps. 115 volts AC — 10 amp. model later in 1959.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

Allen's *New '60 Series* Socket Head Cap Screws



give up to 2⅓ times more load carrying capacity ...without indentation!

In Allen's new '60 Series, head diameter of sizes from ¼" up is now uniformly one and one-half times the body diameter. In many sizes (where this ratio was not called for by 1936 Series specifications) this will provide *more* under-the-head bearing surface, and a proportionate *increase* in clamping force. Loads are more evenly distributed, and the greater bearing area in many cases eliminates need for washers.

Socket sizes have been increased in many cases—greater wrenching area permits higher tightening torque—which resists fatigue failure, and lengthens the life of the threaded joint.

- A new 2-band knurl will identify all ALLEN Cap Screws (except Stainless Steel) that conform to the new '60 Series specifications. New labels on boxes will also identify these.
- The 1936 Series of Allen Cap Screws will continue to be available.

COMPARISON OF ALLEN 1960 SERIES AND 1936 SERIES SOCKET HEAD CAP SCREWS

SCREW SIZE	HEAD DIAMETER Minimum (inches)		BEARING SURFACE Minimum (square inches)		PERCENT OF INCREASE IN BEARING SURFACE[1]	TENSILE LOAD TO INDENT IN SOFT STEEL[2] (lbs.)		TORQUE INDUCED TENSILE LOAD TO INDENT IN SOFT STEEL[2] (lbs.)	
	1960 Series	1936 Series	1960 Series	1936 Series		1960 Series	1936 Series	1960 Series	1936 Series
¼	.365	.367	.044	.044	—	4,750	4,750	2,780	2,780
5/16	.457	.429	.070	.052	33	7,440	5,600	4,380	3,300
⅜	.550	.553	.111	.111	—	12,100	12,100	7,000	7,000
7/16	.642	.615	.140	.103	36	15,000	11,000	8,850	6,450
½	.735	.739	.183	.183	—	19,500	19,500	11,500	11,500
5/8	.921	.863	.293	.216	35	31,000	23,200	18,500	13,600
¾	1.107	.987	.424	.224	89	45,000	24,000	26,700	14,100
⅞	1.293	1.111	.585	.253	131	62,500	27,000	36,800	15,900
1	1.479	1.297	.768	.405	89	82,000	43,500	48,500	25,500

[1]Head tolerance revisions on Sizes #0 thru #10, ¼, 5/16, and ½ diameter have no significant effect on bearing surface or holding power of screws.

[2]Values based on .00025 inch indentation.

Ask your Industrial Distributor about ALLEN '60 Series Cap Screws. Write for samples and complete specifications. Ask for Bulletin G-25.

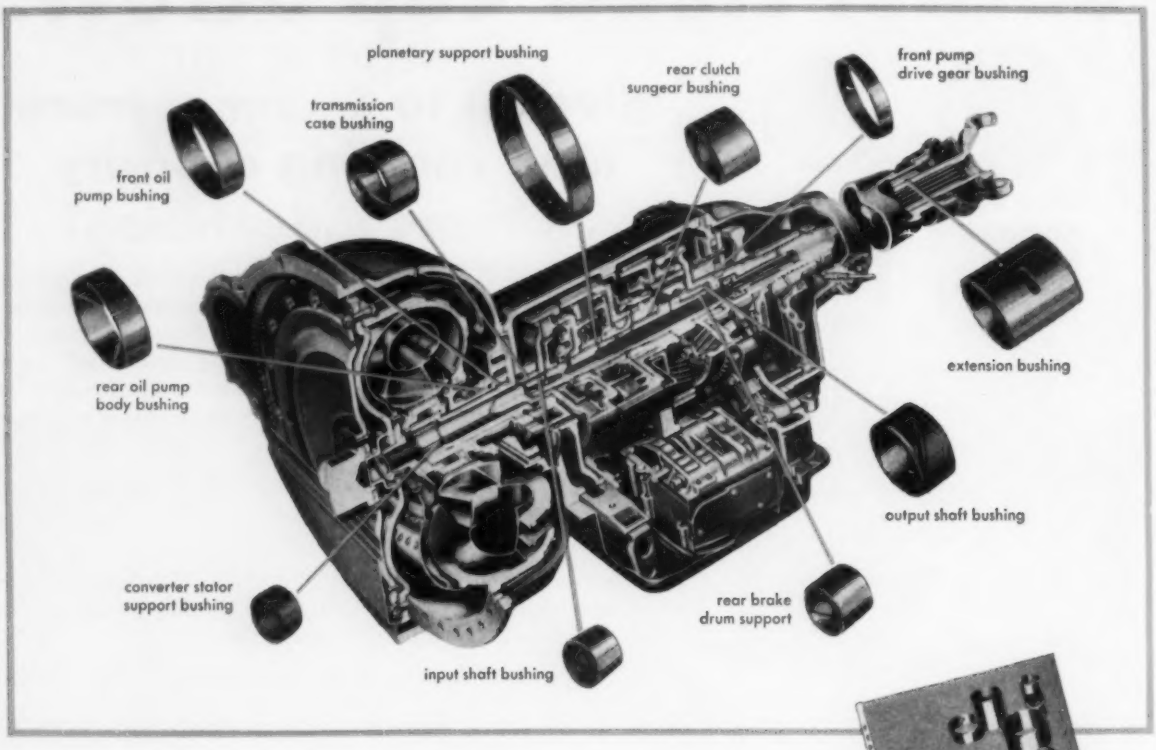
ALLEN MANUFACTURING COMPANY
Hartford 1, Connecticut, U.S.A.

Stocked and sold by leading industrial distributors everywhere

ALLEN HEAD HEX-SOCKET SCREWS

FORMED BUSHINGS...

versatile performers for the design engineer!



This automatic transmission shows some typical applications of Federal-Mogul formed bushings. There are many others, in related areas. Actually, the formed bushing's field of usefulness extends into every assembly involving shaft movement or positioning.

We produce to your specifications, in solid bronze or bimetal. We incorporate your design features—oil grooves or holes, cut-outs, seams, chamfers, ball indentations.

Through our specialized production facilities, the design engineer can solve *both* of his major problems—dependable performance and economical cost!

FREE!

Bushing Design Guide, technical publication by our Engineering Department. Shows materials, size standards, design and application features. Write today!

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FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

Copper-Alloy Lined Bearings

Spacer Tubes

Camshaft Bearings

Precision Thrust Washers

FEDERAL Mogul SINCE 1899

ROCKET ENGINES

NEW tungsten linings for rocket nozzles...

MELTING POINT: 6170°F.

Tungsten-lined lightweight nozzles for solid propellant engines are now being fabricated by General Electric. With a lining melting point of 6170°F, these are among the highest temperature lightweight fixed and flexible nozzles in use in the missile industry, enduring high rocket propellant temperatures and pressures with no measurable erosion.

These nozzles are produced by an arc-spraying process pioneered by General Electric. Tungsten is vaporized in an arc and deposited on a mandrel. For some applications, the liner is molded in lightweight plastic, and the mandrel leached out.

Arc-sprayed nozzles have been hot-fired with the new high temperature propellants at several locations.

G.E.'s capabilities in metallurgy and manufacturing are combined with equally advanced capabilities in engineering, research and development. Integrated advanced rocket engine capabilities at General Electric can meet your needs for high performance solid propellant engine cases, nozzles and liquid engine components using cryogenic and storeable propellants.

Progress Is Our Most Important Product

GENERAL ELECTRIC

The Flight Propulsion Laboratory Department's Rocket Engine Section is the nucleus of General Electric progress in rocket engines and their components. It is well-equipped; and it uses Company-wide capabilities and experience to speed advances. If you would like more information about the section's products and capabilities in solid or liquid propulsion systems, please mail this coupon. Rocket Engine Section, General Electric Co., Cincinnati 15, Ohio.

Section D182-2
Rocket Engine Section
Flight Propulsion Laboratory Department
General Electric Company
Cincinnati 15, Ohio

Please send me additional information about General Electric solid propellant cases and nozzles (GED-3763). ☐

I would like to discuss G-E rocket engine products with a sales representative. ☐

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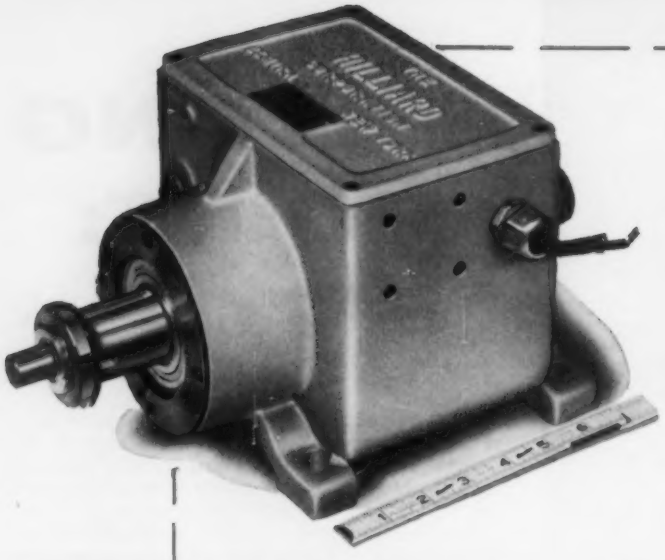
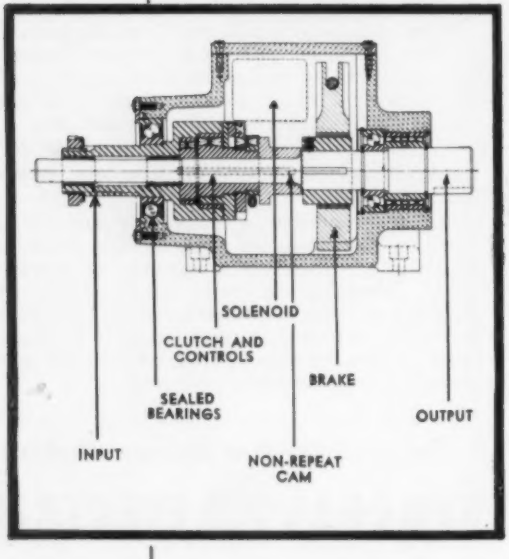


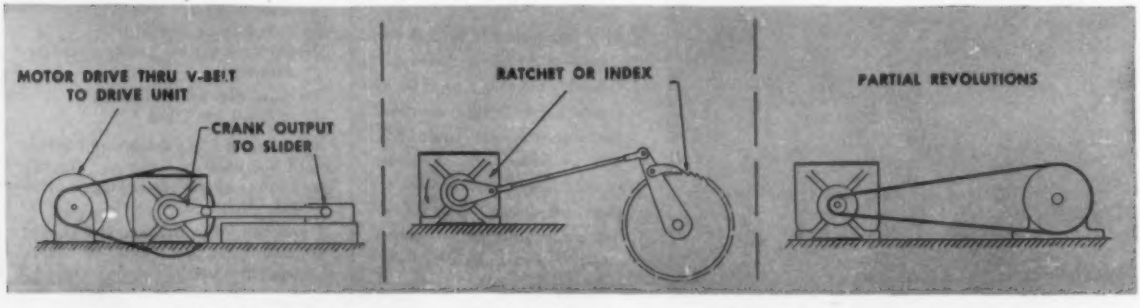
NEW "I.D.U."



"Intermittent Drive Unit" contains all the parts in one package . . .

- Can be installed as easily as a motor and needs only electrical connection.
- Self-lubricating for long life of 40,000,000 or more cycles.
- Operating speed from 40 to 400 R.P.M.
- Torque capacity 36 ft. lbs.
- No cumulative error in cycling.
- Instant engagement.
- Mount with direct coupling connection or use with belt, chain or gear drive.

BASIC UNIT PRICE $289
Optional Accessories Extra



The HILLIARD Corporation manufacturers of industrial clutches for over 50 years
SINGLE REVOLUTION • OVER-RUNNING • SLIP • TWIFLEX • I.D.U.

HILLIARD'S Complete Package Unit that converts rotary power to precise intermittent motion . . .

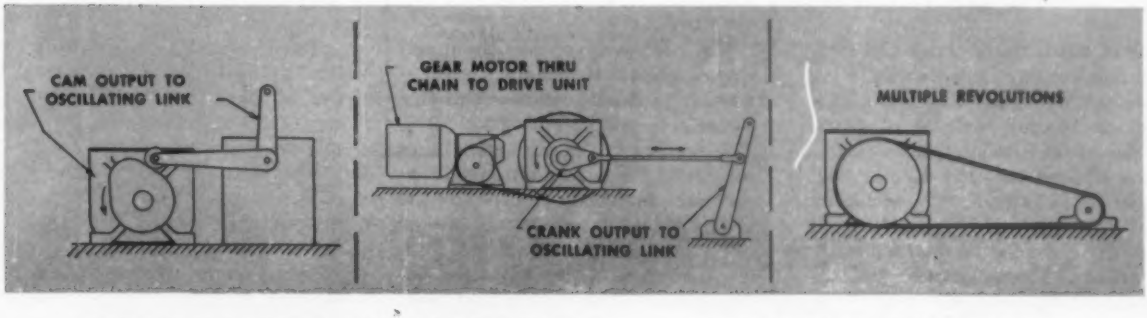
Can be installed on existing equipment, designed into new machinery and re-used after production line changes

Now you can get a single package unit that gives you precise control of intermittent motions . . . clip and bend . . . shear or slash . . . oscillate or repeat . . . raise or lower . . . index and position . . . from a constantly rotating source of power. The HILLIARD "I.D.U." eliminates the need of buying separate parts and assembling a special "custom" machine with assorted mechanisms to apply and control it.

With an "I.D.U." you can mechanize hand or foot operated equipment, modernize or automate existing power operated machines and use it as a "building block" in designing or constructing new machinery or production drives.

The "I.D.U." features highly flexible control, manual, mechanical or electrical, permitting "demand" type operations in fixed or variable cycles. A protected drive, totally enclosed in an oil bath housing, it is ideal for dusty, "steamed" or "wash-down" conditions.

- *Investigate HILLIARD'S "I.D.U." for your equipment. Write on your letterhead stating your intermittent motion problems and we will provide complete information.*


CAM OUTPUT TO OSCILLATING LINK
GEAR MOTOR THRU CHAIN TO DRIVE UNIT
MULTIPLE REVOLUTIONS
CRANK OUTPUT TO OSCILLATING LINK

THE HILLIARD CORPORATION W. FOURTH ST., ELMIRA, N. Y.

IN CANADA—UPTON-BRADEEN-JAMES, LTD.—890 YONGE ST., TORONTO—8760 VERVILLE ST., MONTREAL

Bearings in the making are these lengths of Pittsburgh seamless mechanical tubing in the charging rack of a high-speed automatic cutting machine at the plant of a leading bearing manufacturer. Special machining, hardening properties are built into tubes for this customer who produces more than 6,000 inner-rings per day.

Leading Bearing Maker Finds . . .

Machinability of Pittsburgh Steel's Tubes Lengthens Tool Life, Gives More Pieces

One of the nation's oldest and largest ball bearing makers used alloy bars for high-speed machining of a difficult bearing part for 20 years.

But when Pittsburgh Steel Company showed how low-carbon steel tubes could provide the machining and case-hardening properties required, this big-name manufacturer switched to Pittsburgh seamless mechanical tubing.

These were the clinchers:

- **More pieces per day**
- **Longer tool life**
- **Less machining and scrap**
- **Lower cost material**

The part involved was the inner-ring of a clutch throw-out bearing—a heavy production item at this customer's biggest plant since 1937. The bearing is the part that takes the abuse from the spinning clutch pressure-plate when you step on the clutch pedal.

To produce the inner-ring from low carbon steel, the customer demanded seamless tubing that was:

Highly machinable and uniform—for charging into a battery of 8-spindle automatic screw machines which subject each piece to 16 cutting operations.

Exceptionally hardenable and fine grained—for heat-treating to the hardness demanded of bearing steel and for finishing to ultra-close tolerance and super-fine surface.

The customer specified the grade of steel he needed to obtain these properties—AISI C-1024—then asked Pittsburgh Steel's sales engineers to produce it in seamless mechanical tubing.

The bearing maker's automatic machines produce 6,000 to 6,500 bearing inner-rings a day, testing the tubing's machinability with cutting tolerances as little as .003 inch.

Its hardening properties are

proven in a 21½-hour carburizing-hardening-temper cycle.

Structural characteristics meet the test in an integrated finishing-assembly operation that includes grinding and honing, and two 100 percent test operations.

The bearing maker's superintendent of primary operations sums up the advantages of Pittsburgh Steel's mechanical tubing this way:

"We get more pieces during a day's operation. And we don't have as many chips to pull.

"We can use a boring tool and this stays in service longer than the drill needed for bar stock. Other tools used for ID cuts also stay in longer. So there we have lower tool costs.

"Finally, we are using a less expensive steel and gaining cycle speed. Since the inside drill speed is the controlling factor on cycle speed for bar stock, the elimination of this operation and the substitution of a boring tool permits cycle speeds of 25 seconds for tubing compared with 28 seconds for alloy bar stock or a little over 10 percent reduction."

This customer's experience with Pittsburgh Steel's seamless tubing—the advantages, the quality, the results—is typical of Pittsburgh Steel's ability to supply tubular products for special applications and of its ability to help customers obtain more profitable production.

Initial assembly—one of two 100 percent testing operations—is where seamless shows its merits in finished bearing.

These same benefits can be tailored to the needs of your operation requiring seamless mechanical tubing or any of the other tubular products made by the skilled tubemakers at Pittsburgh Steel Company.

Tubing proves its machinability here where it takes 16 boring, reaming, grooving, recessing and burnishing cuts.

Pittsburgh Seamless Distributors

Baker Steel & Tube Company
Los Angeles, California

Chicago Tube & Iron Company
Chicago, Illinois

Cleveland Tool & Supply Co.
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Drummond McCall & Co., Ltd.
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Earle M. Jorgensen Co.

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CIRCLE 121 READER SERVICE CARD

National O-Rings are precision made, uniform commercial rings available throughout the United States—promptly! Quality is superior; all ingredients are inspected before compounding and compounding is strictly controlled for maximum uniformity. Molding is done on modern equipment by veterans of 20 years in O-Ring manufacture. Every precaution is taken to insure that no O-Rings with cuts, scratches or mold defects are shipped.

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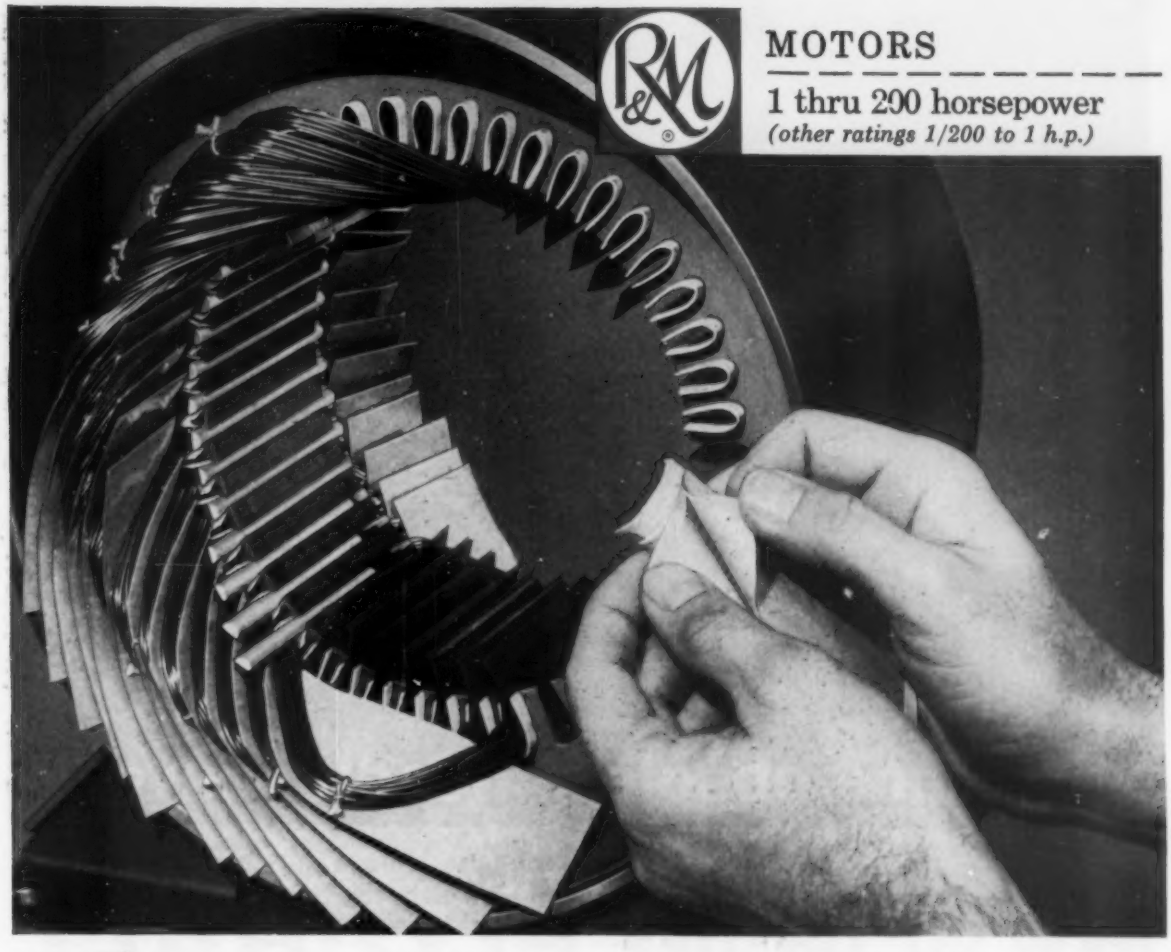
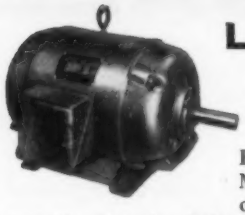


MOTORS

1 thru 200 horsepower

(other ratings 1/200 to 1 h.p.)

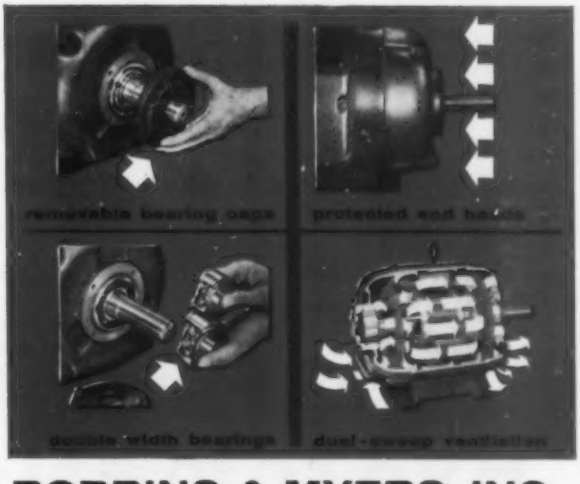


Locked-In, Laminated Insulation

Insures Longer Life for your R&M Motor!

Each slot-cell in your ROBBINS & MYERS motor grips a triple layer of insulation around the windings. Installing these insulation "sandwiches" is a time-consuming job but it pays off in long motor life. Mylar* laminated to rag paper is first inserted. Reinforced edges prevent slipping and scuffing. The dielectric qualities of Mylar* (8 times that of conventional insulation) combined with its resistance to tearing and aging affords permanent protection; the rag paper backing acts as a cushion against abrasion and punctures. A second layer of insulation is inserted to eliminate the danger of weak spots. The wire coil, coated with triple resin insulation, is inserted and a third layer of insulation is placed over it. Insulation is placed between the coil ends, wedges are inserted to hold the coil firmly in place and the stator is twice dipped in special insulating varnish and baked after each dip, thus forming an armor-like coating. Coil ends are coated with a moisture-proof sealer. This is insulation you can trust, yet it's yours at standard prices! For more details write for Bulletin 520 PRE

**DuPont registered trademark*



ROBBINS & MYERS, INC.

motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

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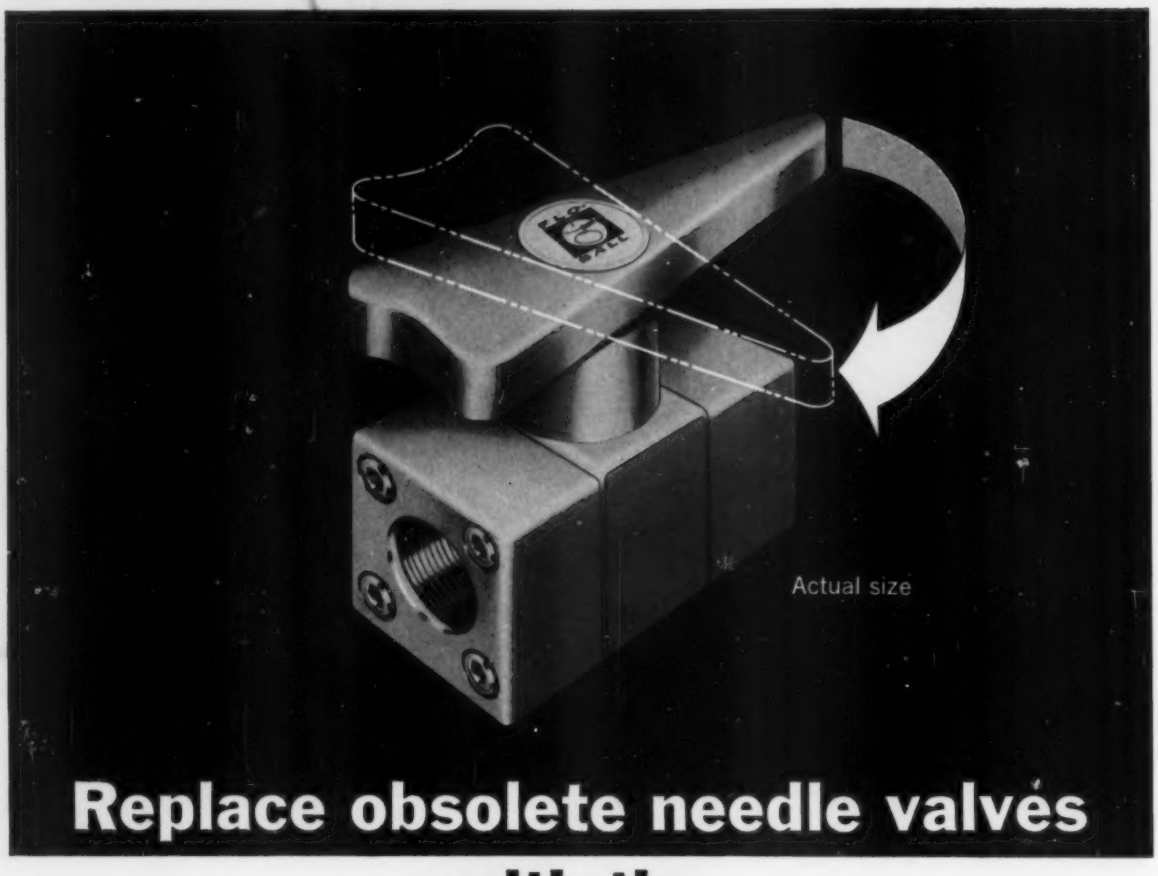


Replace obsolete needle valves with the NEW 90° ON-OFF *FLO-BALL*

For 3,000 PSI...

Low torque, instant action . . . a fast 90° turn, requiring just 4 inch-pound torque at 3,000 psi, actuates the valve instantly!

Priced no higher than needle valves!

100% flow efficiency . . . straight-thru ***FLO-BALL*** design has more than twice the flow efficiency of needle valves!

Positive ON-OFF indication . . . large arrow-shaped handle shows valve position at a glance!

Zero leakage . . . Mass Spectrometer tests with Helium prove zero leakage!

Universal mounting . . . can be panel, side, bottom, or line mounted!

Removable flanges . . . damaged flanges can be removed in seconds; no need to replace entire valve!

All stainless steel construction . . . costs no more than old fashioned screw-type valves!

Versatile service . . . ideal for leakproof control of air, vacuum, steam, water, fuels, oils, kerosene, alcohol, and many other fluids.

SERIES 715			
Port Styles and Sizes			
NPT		AND10050	
Size	Part No.	Size	Part No.
⅛	715A1	¼	715A2
¼	715B1	⅜	715B2

Other models are available for service with cryogenic and corrosive media. Also special designs for throttling flow control.

Write today for new catalog describing the world's most complete line of precision valves for industrial and military applications.

FLO-BALL

Hydromatics, Inc.

LIVINGSTON, N. J. • WYMAN 2-4900 • TWX=LIVINGSTON, N. J. 120

DEVELOPMENTS TO WATCH...

Greases for 700-F service are already available . . .

. . . for applications where air can be excluded, L. C. Brunstrum of Standard Oil of Indiana told last week's World Petroleum Congress, and there is real hope now that materials with good lubricity, usable in air, will soon be at hand. Key to the development is use of new, non-soap thickeners like phthalocyanine, terephthalamate, aryl urea, and indanthrene (*PE*—Dec 9 '57, *p* 9) which offer excellent chemical stability as well as resistance to heat and radiation. Biggest need now, says Brunstrum, is for additives that will increase lubricating ability of the oils themselves (generally, synthetic compounds like the silicones. But success seems near at hand.

An instrument that measures temperatures "instantaneously". . .

. . . across a spark gap 0.015 to 0.030 in. wide is claimed by Jet Ignition Co, Mineola, NY. It's an electronic device specifically developed for studying flame fronts in internal combustion engines, but it may have much wider application. According to the company, temperature is measured independent of heat content and of heat radiated by surrounding bodies, and response time is better than 0.0002 sec. A display unit, with oscilloscope, is provided with the sensing device; and the company says production models, now being designed, will have a built-in signal at 100-F intervals in the 1500 to 3000-F range. The system can, however, be designed for other temperature ranges—down, at least, to 300 F.

Higher temperature operation for semiconductor devices . . .

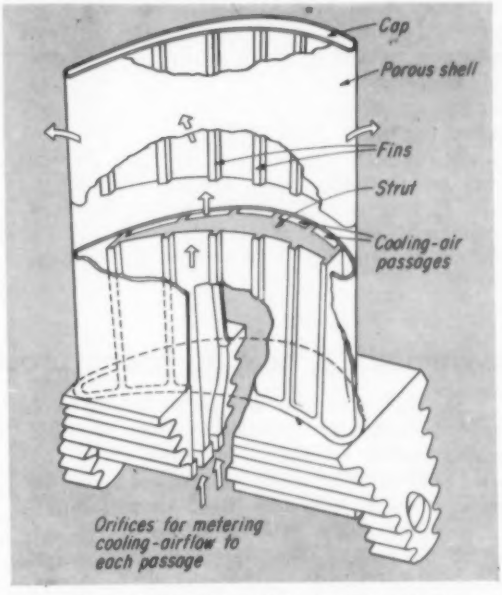
. . . is promised by research now underway at Battelle Memorial Institute. Researchers there report that compounds prepared by direct reaction of rare earth elements and yttrium with such elements as selenium and tellurium "suggest semiconducting behavior, with the possibility of obtaining a wide range of properties," and show good thermal stability, with melting points in the 3000 to 4000 F range. Also under study at Battelle: indium antimonide, aluminum stibnide, and gallium arsenide.

Aluminum blading can be designed for service at 1800 F . . .

. . . French engineers claim. The material isn't pure aluminum, of course, and a cooling system is needed. But the French say the job can be done. The blades are made of a sintered aluminum-alumina mixture, protected by a nickel coating, and are designed for cooling *internally* by a flow of air.

These sintered blades, the French say, have been demonstrated to have a creep limit extending beyond 750 F, and a high heat-transfer coefficient. Since the nickel coating also helps dissipate heat, a metal-to-gas temperature difference of more than 900 degrees can be maintained with only a very moderate cooling air flow.

In this country, work is also being done on internally cooled blades, with designs, like the one pictured, undergoing tests. But, the National Aeronautics and Space Administration says that while such blades will theoretically cool more efficiently than other types of blades, strength and control of porosity both pose major problems. More promising, NASA thinks, are shell-supported blades, which offer "very good heat-transfer characteristics" and are relatively light in weight; and strut-supported blades which offer good heat-transfer characteristics though they do impose a weight penalty.



Internally cooled blades with built-in fins and air passages under test in US include this NASA design.

DEVELOPMENTS TO WATCH...

Columbium and vanadium carbide may be the next hard refractories...

. . . to get the full R & D spotlight. Tests at Battelle Memorial Institute, specifically aimed at finding a better coating for graphite nuclear tubing, indicate that vapor-deposited columbium and vanadium carbide coatings may provide the answer. Their nuclear properties are good, and their heat resistance excellent. Melting point of VC is about 5075 F; of CbC, about 5450. In hardness, both materials rival tungsten carbide. Vickers microhardness (25-g load) tests show VC to have an index of 2700-3000, as compared to WC at 2500.

In the graphite tests, which concentrated on columbium, adhesion of the coating to porous samples was found to be good. Penetration of the base material by the coating served as a mechanical interlock; but adhesion to denser materials still leaves something to be desired. Etching promises to provide an answer here.

Detailed data on the two carbides is hard to come by right now. Very little work has been done on them. But with the need for refractory materials, that situation isn't likely to continue for long.

Another route to direct conversion of heat to electricity . . .

. . . is being explored at Naval Research Laboratory. This is thermomagnetic conversion—a system that takes advantage of the abrupt change in magnetic flux that occurs at the Curie point (temperature at which magnetic properties are lost) in ferromagnetic materials.

NRL could find no evidence of such a generator having been built or tested, so it has made its own, using a nickel strip as the working body. Efficiency —theoretical as well as observed—of such a device is very low. A large amount of heat is required to change the temperature of the ferromagnetic working body and overcome the intrinsic Weiss field. Nonetheless, other materials might do a better job, and this avenue certainly seems worth further exploration.

(Note, for information on other routes to heat-to-electricity conversion, see *PE*—May 4, p 28.)

Aluminum and titanium alloy content may increase severity . . .

. . . of corrosion by boron-containing high-energy fuels of the nickel-based materials which are normally most resistant to attack, say F. J. Loprest and S. J. Tunkel of Reaction Motors. They note that all alloys are severely attacked above a critical temperature (generally 1600 to 2000 F). But intergranular corrosion is considerably less severe in pure nickel and Inconel, which contain little or no Al or Ti, than in Inco 702 and Inconel X which contain relatively large percentages of Al and Ti. Nimonic 75, intermediate in content, is also intermediate in resistance. The reason, they theorize, is that Al and Ti diffuse to the surface of the metal and react with the protective boric oxide film on the surface, producing the free boron that attacks the base metal, and forms low-melting eutectics which then destroy the metal itself.

Interestingly, as they reported to the American Chemical Society's last meeting, corrosion seems to show little or no dependence on velocity of the combustion products in the 75 to 1846 ft/sec range; but it may have an effect at higher velocities.

Asymmetrical heating poses problems . . .

. . . for nuclear as well as space-flight engineers. The undesirable (but sometimes useful) effects of one-side heating on plastics laminates already reported (*PE*—Mar 30, p 20) are matched by similar effects in reactor cylinders (core, thermal shield, and pressure vessel). The latter are heated not only by the coolant circulating in the reactor, but also by internal heat generation produced by absorption of gamma radiation. Result: severe stresses which have led to failure.

The problem is a particularly tricky one because, as Harry Kraus and George Sonnemann of Westinghouse point out, the heating of reactor structures is asymmetrical not only radially but also axially because gamma rays are not emitted uniformly around the longitudinal axis of a nuclear core. Kraus and Sonneman have worked out equations that take both factors into account, and are now developing tangential and shear stress data that should have application well outside the nuclear field. —ARG

Company, Employe-inventor Relations Improving

Individual with patentable idea finds corporation patent policies more lenient than those of Uncle Sam

WASHINGTON—The employe-inventor, who for generations feuded with his corporation bosses over sharing of patent rewards, is finding the US government far more difficult to deal with when it comes to individual rights under defense contract conditions. Result: an employe with a patentable idea is likely to make much more money cooperating with his company than trying to collect from the government.

However, the individual inventor must still run a legal gauntlet before he reaps any more than a nominal financial harvest from ideas grown during employment. Recently, PRODUCT ENGINEERING checked on the nation's larger industrial organizations to learn the climate of employ-inventor vs company relations.

HERE'S SOME METHODS

More large corporations give considerable attention to patent policy, establishing patent sections for full-time consideration of such matters. North American Aviation Inc set up a wholly owned subsidiary, Navan Products Inc, specifically to market NAA's inventions (*PE—Mar 9, p 37*).

Most companies make it a policy to have new employees—especially design engineers—sign a patent release form. Forms usually contain a clause reading ". . . employe agrees to assign XYZ Corp all of his inventions—related to products and methods by which they are manufactured during his employment. Employe also agrees to assign to the corporation any and all US and foreign patents on any such inventions which may be issued to him. . . ."

Some companies still don't require a patent release—Hewlett-Packard Co of Palo Alto, Calif for one. However, should an employe invent something, he is expected to assign the patent application to the company. This could pose a problem. The inventor may leave the company, and might years later apply a development he conceived during his employment to an invention. It might prove difficult to get him to sign over the patent rights. In this case, the company must prove the invention was related to the previous employment, and then would be permitted to exercise its shopright privileges. (Shopright is nonexclusive, irrevocable license of company to use an invention when employer's equipment, materials, labor, etc, have been used by the inventor to create the idea.)

POST-EMPLOYMENT PROBLEMS

Biggest bone of contention is matter of whether inventor created his idea without assistance from the company. Considerable litigation ensues once an employe departs the company scene and attempts to merchandize his idea elsewhere. But the scales weigh in favor of the employer who can point out that the inventor has access to company records, hears all sorts of technical conversation and can apply these to his inventive efforts.

Where the company is interested in a product that would result from the invention, it may license the employe to springboard his invention into manufacture as does Lockheed. It may even, as does Boeing Airplane Co, offer to help set the employe up in business to market his idea separately. If the invention is unrelated to a company's products or processes, the company will then assign full title to the employe.

Only about 25% of the nation's

A new glue for glass . . .

that has given TV tube design a lift, promises safety, simplification and cost reduction for many laminated glass assemblies—from auto glass to chemical processing components. Developed by Dow Chemical Co for implosion-proof TV tubes, the new adhesive is a water-thin epoxy formulation that gives a strong bond under cyclic temperatures from —40 to 160 F. Key advantage of the new method is that precision glass surfaces are no longer required and the high heat-pressure cycle has been eliminated. Two joining surfaces are positioned in a jig to a minimum space of 60 mils, heated to 210-230 F, and warm, catalyzed resin flowed between them from an automatic dispenser. For TV tube applications, above, a flat tip nozzle is inserted for easy access. Visual inspection tells when a uniform film exists between laminations. Cure is well underway within 5 minutes, and a further 15-20 min cooling period completes the joint. So far, TV tubes are the only commercial application of the new technique.

larger companies pay a set royalty percentage to the inventor; a situation that still irritates many inventors. The remaining 75% offer raises, bonuses, stock options; a limited few give nothing, arguing that engineers are hired to invent. But these often invite subsequent litigation.

The Dept. of Justice has been known to criticize corporations for requiring patent release agreements from its new engineers without offering patent royalties. Yet the government, particularly under the "Space Act," will not only take over an employe's invention if it's at all related to a defense contract operation, but will require him to give up all drawings and technical background data connected with the invention.

Within burgeoning US economy, the number of instances of disagreement between inventor and employer has increased measurably, adding considerably to the already crowded calendars of state courts. However, survey indicates that within larger companies employe-inventors are more and more becoming reconciled to corporate patent policies. Also big companies are nowadays more inclined to be lenient with license and royalty payments to maintain high morale among creative employes. The latter in most cases, aware of high costs of litigation, go along with their employers.

From Chicago, patent lawyers John Diener Jr. and Charles W. Rummler comment that nowadays the National Aeronautics and Space Act along with the Atomic Energy Act give the individual inventor more trouble than any corporation. "These Acts are too restrictive," they say. "If the corporation is big enough, it can talk back to the government, but the little guy can't . . ."

READ RELEASES CAREFULLY

Discussing court examination of patent conflicts between employe and the company, the two patent lawyers report that companies in fast-growing areas of technology, such as aircraft-missiles and electronics where personnel turnover is frequent, are more particular about requiring patent releases from employes. Rummler adds that engineers who switch jobs should be careful about the kind of patent agreement they sign. "The engineer is often hired for his inventive ability, so when he moves to a new job, he should be sure his contract protects him against loss of inventions he already owns."

In the automotive industry where competitive considerations are uppermost in the minds of management, patent releases are all inclusive. One company takes title to just about everything an employe could possibly invent. Recently, one employe, working as an engineer in a company's jet aircraft engine plant, designed in his own time an air conditioner for an automobile engine. Aware of the company's restrictive policy, the employe quit his job so he could feel free to market an idea he had created with no assistance from the company.

STRICTER BUT GENEROUS

The aircraft companies, who require more binding patent release forms, are most generous with royalty dispensation on inventions credited to the employe: Lockheed offers 20% on first $100,000 received, 10% on the next $400,000; Northrop pays 10% on first $5,000, 5% on next $5,000, 2½% on next $10,000 and 1¼% after that; Convair offers 30% of first $1,000, 25% of second $1,000 and 20% of anything after that.

Generally, the inventor—dwarfed by gigantic companies with limitless resources not only to develop and market an invention but also to fight a rebellious inventor who gets out of line—is nowadays inclined to cooperate with his employers who will in most cases (if they're big enough) see that he's well treated. And, if an argument arises with the government in connection with an invention created under a US-sponsored project the large corporation is in a much better position to debate the matter, thus aiding the inventor.

PROTECTIVE LAWS ON BOOKS

Additionally, the larger company won't chance the bad publicity of a charge that it "seized" an employe's idea. Where the stakes are high, a smaller company may attempt it but the patent laws are framed to protect the individual who is in a good position to battle the smaller firm on more equal terms: Article I, Section 8, of the Constitution of the US states in part: "The Congress shall have power . . . to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive rights to their writings and their discoveries." This was followed in 1790 by the first patent laws—which stand on the books today little changed. ■

Aluminum amphibious carrier . . .

developed by Food Machinery & Chemical Corp is new lightweight, fulltracked personnel vehicle which cruises at 25 mph, can travel 200 mi on self-contained fuel supply with a top speed of 40 mph; and can climb a 60% longitudinal slope and a 30% side slope. It can also cross a 66-wide trench, and roll over a 24-in high obstacle. The M-113 is 189 in. long, and 105 in. wide, and overall height of 86 in. Combat loaded, it weighs 22,163 lb, with a design gross of 24,000 lb. Its air-drop weight is 18,200 lb. Powered by a 215-hp Chrysler V-8 engine, the M-113 can operate in temperatures as low as —65F. Vehicle can carry 12 men, is equipped with 50-cal machine guns.

Seek Geographic Restrictions on Defense Contracts

WASHINGTON—A bill sponsored by US Sen Jacob Javits, (R NY), which would increase percentage of prime defense orders awarded in labor surplus areas and to small business firms and suppliers is being vigorously opposed by California legislators and businessmen. Javits proposal calls for "more open bidding," and an increase in the amount of design proposals offered on defense contracts, and, in particular, an increase in percentage of contracts awarded to New York State. Here's what the opposition has to say:

While the interest of Sen Javits proposal is above reproach, the mechanics of bidding for defense business—say, for example, a design study contract for a complete weapons system—are so expensive, so interrelated with subcontracting, that any insistence on more "competitive bidding" would result in numerous unsuccessful bidders who would have to absorb the staggering cost of preparing and submitting the design proposals.

Opposition to Javits is focussed in California where much of current defense contracts business is headquartered. This "defensive unit," made up of directors of the Chambers of Commerce of Oakland, San Francisco and Los Angeles, argue that while the government may—as it did, in the case of the WW-II chemically-fueled bomber—award design study contracts whose initial design concepts look promising, Defense Dept would fight vigorously any proposal to award more design study contracts than absolutely necessary.

However, at a meeting in Wash., DC held last week, a delegation of Californians were amongst state representatives from all over the US who heard Sen Javits explain his proposal as contributing to health of the nation rather than one region. ■

Navy Shrouds Design Details of Radio Telescope in Secrecy

WASHINGTON—A radio telescope reported as 19 times more powerful than the world's largest optical scope at Mt Palomar, Calif is being developed by the Navy to bounce radio signals off the moon (and man-made satellites) for communication, navigational uses and satellite tracking. The new scope, being built on a 1500-acre mountain site near Sugar Grove, W Va, will have a reach of 38 billion light years, and is said to be twice as big as anything the Russians are building.

The scope's designers—Grad Urbahn & Seelze, NYC—report that this installation's radar disk will be 600 ft in dia, will use 20,000 tons of aluminum-lined steel; as such will be the world's largest movable structure. It is reported that engineers will erect two big towers and equip each with 230-ft booms.

Within two miles of the site all electrical interference is banned. Navy engineers will go into this area and install suppressors on existing electrical equipment that the few farms and business establishments already there have.

Navy will put the noise suppressors on such items as electrical toasters, radios, TV's, electrical motors, etc. It will bury all power and telephone lines running into the site. Support facilities such as personnel housing, repair shops, etc will be located four miles from the big telescope. Suppressors will even be installed on the distributors of all vehicles operated on the Navy facility.

Previously, Navy has touted the facility as "a foremost scientific tool . . . not only in study of outer space . . . but also in advanced scientific research and characteristics of the earth's atmosphere, and geodetic and geomagnetic data on the earth itself."

New telescope will cost $79 million to build, is only 30 miles from a smaller radio scope being built by National Science Foundation. Congressional charges of waste were countered by Navy officials who stated that the big installation is 90% for military purposes.

A 60-ft pilot radio-telescope is being installed at the Sugar Grove site to help engineers detect local radio interference so suppressors can be installed on the electrical equipment.

Despite reports that have reached the press regarding the new telescope, Navy expects to maintain charge of secrecy on design details. Competition with USSR is reason for news blackout. ■

Thin Steel Makes Tough Cylinders

WASHINGTON—Paper-thin steel, 0.008 in. thick, is now being welded into sheets that will withstand ultimate stress of 305,000 psi under static tension at Ryan Aeronautical Co.

The achievement was reported here at the Society for Experimental Stress Analysis by Robert J. Voth, a Ryan Loads and Test Group Engineer. The development grew out of experimental work leading to cylindrical pressure vessels suitable for rocket engine cases.

Heretofore, industry has had difficulty reaching 240,000 psi in a single thickness of sheet that is either spun or rolled to form a solid wall cylinder, Voth reported. In the Ryan process, sheets of the thin steel are wound on a mandrel. When they attain the thickness desired for the cylinder wall, the layers are tackwelded and resistance welded, Voth said.

Ryan engineers, he added, have been raising the limit of material's usable strength through modifying spotwelding techniques to requirements of the paper-thin steel. ■

NASA Assigns Basic Research Contract to Universities

WASHINGTON — Of $27.6-million in contracts written by the National Aeronautics and Space Administration during a recent 30-day period, more than $1-million was assigned to 10 universities for basic research.

Largest single amount ($24-million)

went to Douglas Aircraft Corp for development of Delta, a 3-stage launching vehicle. A $50,000 contract was awarded to MIT to develop an atomic space clock to operate with cesium vapor. ■

India to Have Design Center

NEW DELHI—An Institute of Industrial Design has been proposed for India with the idea of stimulating designs for industry which conform to the nation's environment. Training will include designing for large-scale, medium, and small industries.

The Ford Foundation is willing to assist India. A technical team from the foundation is due to tour the country and, among other things, will suggest a site for the Institute.

Present tentative site choice is at Ranghi (Bihar state), close to the heavy-machinery plant being designed and erected by the Russians. In addition, a design office is proposed near the coal-mining machinery plant at Durgapur (West Bengal state).

In what is called the private Indian sector, there is no original design work going on. However, according to one source, The Indian Tea Association has patented what is called a Rotovane Tea Roller, now being produced by the Port Engineering Co of Calcutta. ■

Army to Fire Supplies by Missile

WASHINGTON—The experience in deceleration and recovery techniques being gained in its manned satellite program is speeding the day when the Army will use the ballistic missile as a mean for transportation of material. This is the opinion of Capt D. F. Kelly Jr of Army Ordnance Missile Command, speaking at the annual meet of OMC's Research and Development Association.

Army has long considered the missile an ideal means of transport during limited warfare, i.e. for lobbing food and medical supplies to small units pinned down by enemy fire. Such a missile has also been suggested as a means of moving mail. But it has only been during the past year that such systems have actually been tried; and while much of the development has been done by private companies at their own expense, the Army expects now to use its own budget to effect progress along this line. ■

More Uniform Drafting Practices

NEW YORK—Another step in obtaining uniform drafting practices throughout the US has been achieved with the approval of the American Standards Assn of Sec 17—Fluid Power Diagrams—of the American Drafting Standards Manual.

Sec 17 establishes standard drawing practices for depicting systems that uses a fluid (liquid or gas) with enclosed circuits to transmit and control power. Explained in detail are data and notes that should accompany symbols and lines to make a diagram meet the requirements of engineering, sales, purchasing and maintenance.

Four types of diagrams are covered by the standard: pictorial diagrams, which show only external features of components; cutaway diagrams, which show principal internal working parts; graphical diagrams, which provide a simplified method of showing function and method of operation of each component; and combination diagrams, which combine the previous three to emphasize, for each part, the function that best suits the purpose of the diagram.

Standard symbols for each type of diagram are illustrated in Section 17. These symbols include components; piping; and capacity, power and other ratings. Standard drafting practice is used for such things as line conventions, lettering, sheet size, and title blocks. ■

Engineering Education Again Criticized

WASHINGTON—A report sharply critical of US education in science and engineering has been issued by the president's Science Advisory Committee after more than a year's study of high schools, colleges and graduate schools. Wholesale revision of outdated engineering courses, more and better graduate schools, and an immediate doubling of America's investment in education, keynote the report.

Prime problem area is the high school, reports the committee headed by Dr Lee A. DuBridge, president of CIT. Only a few high schools have "real academic strength" and whole regions of the US may not have one first-rate high school. And science teachers are especially acute. 9000 college graduates will take up science or mathematics teaching this year—14,000 will leave or die.

College curricular reforms are also long overdue, the report finds. Basic engineering and math, plus the liberal arts engineers need, can fill up the four years. Detailed specialization should be deferred for graduate school or on-the-job training. Technical institutes should be greatly expanded for lower-level engineering work.

More graduate engineering schools should be developed in universities which have top science departments, because such fields as quantum theory, boolean algebra, and nuclear structure have increasing engineering applications. Development of more PhD's in engineering, the report insists, is the only way to nourish those "relatively few" minds from which the brilliant and far-reaching discoveries and inventions of the future will come. ■

COMING EVENTS

JUNE

14-18 . . . . American Society of Mechanical Engineers, Semiannual Meeting, Chase-Park Plaza, St. Louis, Mo.

14-19 . . . . Society of Automotive Engineers, Summer Meeting, Chalfonte-Haddon Hall, Atlantic City, NJ.

15-17 . . . . American Nuclear Society, Annual Meeting, Civic Auditorium, Gatlinburg, Tenn.

15-18 . . . . American Electroplating Society, 50th Annual Convention and Industrial Finishing Exposition, Detroit.

17-19 . . . . National Society of Professional Engineers, Annual Meeting, Commodore Hotel, NYC.

WELDERS OF MEN

The American business man is pictured as the dollar chaser, reportedly interested only in making money. Some are like that. But some others build their businesses to a top position by engineering a good product—and at the same time become nationally famous for social-mindedness and good works. Two such men in the same company, the Lincoln Electric Company of Cleveland, have just passed.

They worked as a team part of the time, and part of the time on their own divergent paths. John C. Lincoln, 92, founder and president of the company became widely known as the champion of the single-tax, incentive pay and enlightened management.

Alton F. (Charlie) Davis, 69, vice president and secretary, is the prototype of the aggressive and original public relations executive. Together they established an annual award for welding design that helped build an industry with a solid $100,000 in cash each year. They also established foundations that served in their respective ways. Both were fearless in what they said and did. What they stood for they supported with no reservations. When necessary, they fought for their beliefs—against politics, against organizations, against any vested interest. And they won. In a world that tends to be static, they stood for change; in a world warped to the dollar they stood for sense, common sense—and they made dollars doing it.

Now both men are gone, and within 24 hours of each other. But we will remember the "little" things they did: The first $100,000 check, which was welded beads on a steel plate. The welded monument in the Arizona desert to the U S Army Camel Corps. "Charlie's" Christmas cards which reprinted sermons that had moved him. The Ohio State library of books on welding. The work for hospitals. Mr. Lincoln's supported defense of his single-tax—even to running for vice president in 1924. And on and on.

Meanwhile they built—and sold top-quality arc welders. They were business men with hearts—and guts. Of such stuff is history made.—EJT

Reader To Editor...

Doctor's Point of View

To the Editor:

As an individual versed in the disciplines of both medicine and engineering, I would like to offer a constructive criticism relative to the reporting of medical engineering information. Unfortunately, much of the equipment used by physicians has been developed by the engineering profession without suitable rapport with the situation in which it is used. The resulting equipment is well designed from an engineering standpoint but not well oriented to medical usage.

I point out this situation because I feel it would be helpful to both professions if the reporting in publications such as yours was oriented to the needs and understanding of the profession in order to create a clear and more useful picture in the mind of the reader. As an illustration, may I point out the article on page 37 of your April 13 issue which describes "Electrode Search Diagnoses Body Organ, Tissue Illness." From this brief article an uninformed engineer would assume that this device could be used to make many different medical diagnoses. In actual fact, assuming that this device does as it is described, at best it could only evaluate a single "sign" which might or might not be common to a myriad of disease conditions.

As one learns more of the complexities of chemical, electrical and physical interactions of the systems of the body it becomes more apparent that any such simple system could not produce a diagnosis except in rare instances. The description in your magazine is reminiscent of advertisements for chiropractic diagnostic instruments which have been generally naive in their basic concepts.

—W P Murphy Jr, MD
President, Cordis Corp
Miami, Fla

Wrong, Mr. Fiderer!

To the Editor:

In the "Reader to Editor" section of the May 11 issue (p 28), Mr Leo Fiderer disagreed with one of the methods recommended by Mr F. W. Wood Jr in his article, "Single-plate Gear Trains: 11 Ways to Mount Shafts" *(PE—Jan 5, p 68.)*

Mr Fiderer's statement that the axial play as well as the radial play cannot be controlled by means of retaining rings is not correct. The axial play of assemblies can be taken up resiliently with "Bowed Retaining Rings" or taken up rigidly with "Beveled Retaining Rings." Both types have been available in several variations for quite some years and standards for these rings have been issued by the Department of Defense under the following Military Specifications numbers: MS 16628, MS 16629, MS 16630, MS 16631 and MS 16634.

The radial play of gears on shafts can be eliminated only through proper fit of the mating parts and not by pinned collars or other shoulders.

Stress concentration at the point of maximum bending moment is prevalent whether collar pins (drilled holes) or retaining rings (grooves) are used. However, since the recommended depth of retaining-ring grooves is small compared to the diameter of the shaft, the stress-concentration factor is small as well, in most cases. Furthermore, the use of relief grooves with retaining-ring grooves will also reduce stress concentration considerably.

Very often, parts can be damaged when holes are drilled for pins after the parts have been assembled. In the case of retaining rings, damage to parts cannot occur since the grooves for the rings are cut prior to assembly.

The assembly of gear trains with retaining rings saves space, material and time and should certainly be considered a good design practice. This has been proven by the wide acceptance of retaining rings as machine shoulders in all branches of industry.

—Hugo Wurzel
chief design engineer
Truarc Retaining Rings Div
Waldes Kohinoor Inc

Remember Thoreau and Rousseau

To the Editor:

In your Mar 23 editorial, "Freedom and the Uncommon Man," you raised some interesting points in regard to human freedom.

Conspicuous by their absence were Thoreau's views on the subject that took him into seclusion at Walden Pond and Rousseau's statement, "Man is born free and found everywhere enchained." Contrasting both these viewpoints, the social thinkers of the present are pretty much in agreement that the man of 1960 has more freedom than any who has inhabited the earth before. Their views are founded on the observation that civilization is the result of man's efforts in cooperation and knowledge-pooling in order that he can free himself for more individuality.

Continuing in this direction, and at the risk of being unfashionable, I think that the present American fixation with conformity is very certain to decline. With more people becoming better educated, how can it be otherwise? The social confusion that has resulted from our 40-hr work week and the excess of leisure for people who have no heritage of constructive leisure could well be the culprit responsible for the "desperate conformity" that is so widely discussed today.

Our new leisure pattern perhaps results in the lack of a comfortable social niche. Could this be partly what is constricting our individuality? —John Coley
Chicago

FOURTH DESIGN CONFERENCE . . .

Four days of detailed design information on mechanical components, materials, controls and power were highlighted by general engineering organization. Here are high points of these sessions held at Philadelphia, May 25-29.

GERMANY IS HEADING FOR DESIGN PROMINENCE

PHILADELPHIA—Some 500 design engineers heard Hellmuth Walter, director of research, Worthington Corp, warn America it's pricing itself out of the world market—and German engineering education and design can further cut our export. "Maybe not tomorrow," Walter said, "but the next decade will be critical in world design history."

DEFEAT WAS A BLESSING

"Dismantling of German machine tools after the war was a blessing in disguise, as was the labor supply forced into West Germany by the Russians," Walter reported. Rebuilding gave work—and a 90% wage increase in the past 10 years. But prices increased only 20%, leaving the German worker with 60% more buying power. Today, Walter continued, labor flow is still being absorbed, productivity continues to increase, yet the wage rate is still only 25% that of US workers.

SCHOOLING IS GERMAN STRENGTH

Most of the engineering strength can be traced to the German educational system, according to Walter. Automatic promotion in school is unknown; about 10% fail each year and must repeat a term. All students get four years of basic education; then out of 100,000 students about 69,000 continue in the public schools, 11,000 go to the middle school and 20,000 to high school. All study two foreign languages, math, physics and chemistry, and must pass a strenuous exam to graduate.

Of the 20,000 entering high school, some 4250 graduate—900 entering the technical university, joined by 100 more from the intermediate technical school system. Of these 1000 students 650 become "Diploma" engineers—the equivalent of an MS degree—after 18 years of schooling.

AUTOCRATIC WITH BACK TALK

"The organizational form in Germany may be defined as autocratic with back talk," said Walter, "which leaves the individual some elbow room." Committees don't exist except for standards and codes. A single person makes the decision in Germany —which can lead to some grave mistakes but also to success.

A typical example of success, Walter said, "is the Volkswagen, conceived, by one man—not committee action. This product seems to contradict the typical American car in every way, except that it has wheels. It is small, economical; it does not change its appearance; every part of it is functionally justified; and it is hardly advertised," Walter said. "Yet it is a highly successful design and sold all over the world."

However, German firms, particularly those engaged in mass production, are continuously studying American managerial forms and practices, and will undoubtedly adopt many of them. "Inevitably," said Walter, "the design engineer is not any more the creative genius, the problem-solver and troubleshooter, but instead becomes part of an enormous machinery which needs only to be maintained and kept running. The German design engineer is striving to be a part of management."

Psychology and Engineering Do Mix

PHILADEPHIA—"Human behavior is essentially emotional, not logical," says Martin Bruce, vice-president of Clark Channell Inc, "and an organization

. . . and THE DESIGN SHOW

A booth-by-booth study of new ideas, new concepts, new components and materials the editors found in a careful, critical, complete evaluation of each exhibit — including some "under-the-counter" items.

must take this into account." For engineering and research setups, a decentralized organization—such as GM and GE—is normally used as engineers and scientists work best in a democratic atmosphere.

"Regardless of the organization," Bruce told the gathering of engineers, "a businessman runs the company and makes the decisions." But, as any business is made up of people, their handling is a major factor in productivity. Industrial psychologists give the company president a practical view which might otherwise be lost. "In other words," Bruce said, "the social scientist is consulted to broaden perspective for understanding." Also, the psychologist should be a staff job, not a line job, in the organization.

In Bruce's view, all organizational structures are based on trial and error; there is no general organization that can be applied. The psychologist uses research to approach an answer but must evaluate each of the forms of structure.

"Normally," said Bruce, "the company suggests the approach; psychologists gives the advantages and limitations, and it is then the president who selects the final structure."

—Robert E Abbott

SPOTLIGHT ON—THE EXHIBITS THE TRENDS

Application, rather than innovation, keynoted this year's Design Engineering Show. But this relative scarcity of "revolutions" and "breakthroughs" is good news rather than bad. Suppliers gave plenty of evidence that they're catching up on needed technical data and application information, and on fitting previously-announced developments to meet specific engineering needs of changing technology.

Conscious of rising labor costs, many suppliers featured ease of installation for their components. This took the form not only of devices that install faster, but of systems that lend themselves to more-automatic production and ideas that aid assembly work.

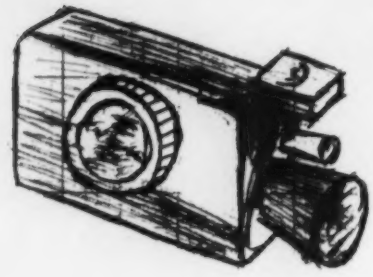
There was much evidence, too, of behind-the-scenes activity in developing fabrication know-how that will make it possible to supply the newer materials in a wider range of shapes and sizes. But exhibits showed a good deal of progress has been made, even in the past year.—Robert W Carson

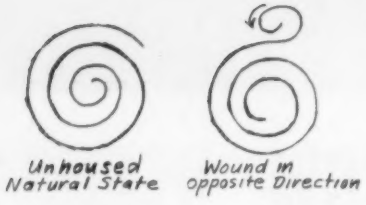
MECHANICAL COMPONENTS

New components were in more conservative fields, such as gears, springs, clutches, bearings and lubricating systems—generally as improvements but with some real innovations.

Prestressed Power Spring . . .

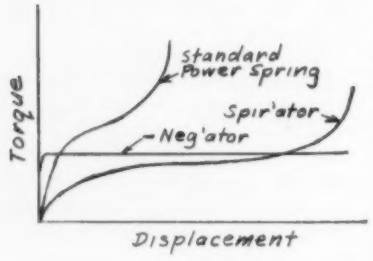
. . . in winding knob of new Argus M-3 camera produces an almost-constant torque output over a wide range of displacement. Called the Spir'ator by its manufacturer, Hunter Spring Co, Lansdale, Penna, the spring resembles an ordinary spiral or power spring. Although Hunter has not released complete details, it is believed that the coils are prestressed into a





spiral form. Before assembling the coils into their cup-like case, the coils are wound in the opposite direction. The result is approximately constant torque as the spring runs down, giving more running time than a spiral spring occupying the same space.

Favorable residual stressing of the Spir'ator material permits higher working stresses which, in turn, allow use of thinner material and subsequently longer length in the same case size. Also the tendency of the spring to thrust outward from the hub makes

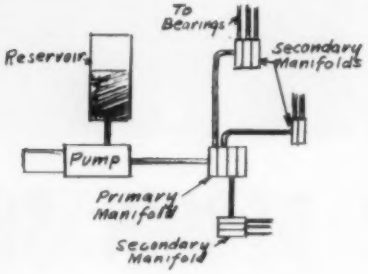


the active length greater than for a conventional spiral power spring.

As a power spring, the Spir'ator in comparison with the Neg'ator spring (by the same company), is more compact in that it uses only one shaft as compared with the Neg'ator's two shafts. This feature permitted Argus to put the Spir'ator outside the camera and directly inside the winding knob. Although its torque-deflection curve is not as flat with the Neg'ator, the Spir'ator will likely displace the power spring in many applications.

New Lubrication System . . .

. . . for small machine applications now makes it economical to set up an automatic system to lubricate as few as only two bearings. Manufactured by the Farval Corporation, Cleveland, the system uses a single line to feed either oil or grease to the lubrication points, in contrast to the dual-line



systems more commonly employed. The series circuit is simpler—but a break in the line affects the entire length of that series. Farval overcame this difficulty by designing pop-out plungers at the ends of each manifold to visually indicate the trouble spot.

Basic system consists of pump, reservoir, and primary and secondary manifolds so selected as to divide the pump delivery into varied "slugs" of lubricant, each slug channeled to its specific outlet. The system was originally developed in England by Tanway Co, but recently acquired by Farval who then modified the system (it is now called the Farval-Tanway system) to meet the trend toward centralized lubrication for the smaller machines such as machine tools, small presses, fork trucks.

Purpose of the banks of manifolds is to provide a positive method of dividing the lubricant into specified amounts. For example, the pump, which can be operated manually or by power, is triggered to send out a slug of lubricant at predetermined time intervals. The primary manifold divides it into slugs of selected size, and the first of the secondary manifolds in turn, can further divide its share of the original slug. Each valve in the manifolds is selected to feed a specific quantity.

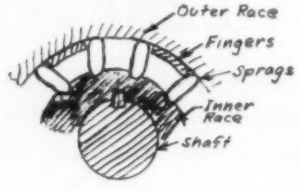
The system also can be equipped with visual alarms, indicators, timeclocks, or with a special device to record the lubrication cycles.

New Sprag Clutch . . .

. . . transmits motion only from the input side. Produced by Formsprag Co, Warren, Mich, it acts as a normal coupling when the input shaft is rotated in either direction—it merely transfers the motion to the output side. But the output shaft, by itself, cannot be budged.

This principle prevents power feedback and opens up many applications. This clutch, for example, would prevent road bumps from shifting the wheels of an automobile. Or an unbalanced mass could be rotated to any position and then released—the clutch would hold it in position.

Here's the way the clutch works. Sets of skewed sprags are located

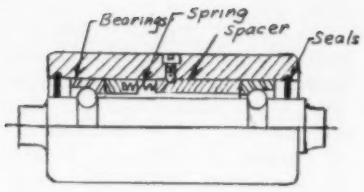


around the circumference of the inner race, which is keyed to the output shaft. The sprags prevent any relative motion between inner and outer races. The outer race always remains stationary (bolted, possibly, to the frame of the machine). The fingers, spaced between the sprags, are connected to the input side. Thus, rotation of the input in any direction causes the fingers to kick over the opposing sprags and permit the inner race to rotate. The output shaft, however, does not control the fingers, and its rotation only causes the sprags to "dig in" and resist the motion.

High-speed Bearings . . .

. . . are now packaged as sealed units and specifically designed to operate at speeds in excess of 100,000 rpm. These units, produced by Marlin-Rockwell Corporation, Jamestown, NY, are easily adapted to existing equipment and are designed for high-speed grinding spindles, dental drills, turbine generators, printing machines and machine tools (the dental drill operates at 200,000 rpm).

The two angular-contact bearings in the unit have no inner race—grooves are ground directly into the shaft. This cuts down radial space require-



ments, and reduces shaft eccentricity because the shaft ends are ground with respect to the grooves. Tolerances are to ABEC 7 grade.

The bearings are preloaded by means of the spring-loaded spacer. This produces more stability, prevents ball skidding during fast starts, and avoids fretting corrosion when the unit is not under load but subject to vibrations from outside the bearing. Spring loading takes care of thermal expansion of the shaft during temperature rises caused by the high speeds. The unit is then grease-lubricated and sealed.

Many configurations are possible using this principle. MRC at present makes the bearings to customer requirements. Sizes are usually below 2½ in. OD because of the speed requirements. Bearings for operation above 100,000 rpm seldom exceed ½ in. OD.

New Right-angle Gear System . . .

. . . employs teeth with unequal pressure angles to reduce noise during operation.

Designated as "Helicon" gears, this system is the newest development reported by the Spiroid Division of Illinois Tool Works.

The system employs a worm-type gear for the pinion, with a constant lead angle but with teeth that have a 10 to 15° pressure angle on one side, and a 30 to 35° pressure angle on the other side. The pinion mates with a face-type gear—shaft centerlines of pinion and gear in this system do not intersect.

The new gears can be made with ratios from 3:1 and up. But their main applications are for ratios below 10.1 where the gears can be molded or cast.

At quantity orders, and for these lower ratios, the Helicon gears are less expensive and quieter than bevel gears, and have 3 or 4 teeth in contact at all times as compared with single-tooth contact of bevel.—**Nicholas Chironis**

NEW MATERIALS AND PRODUCTION PROCESSES

Along with new materials for extreme environments, novel methods of forming materials were a refreshing undercurrent at the Show.

Upset forgings now longer . . .

. . . by 40% is the result of Commercial Shearing and Stamping Co's tinkering with the basic process. Design limits established for some time have held the length-to-diameter ratio to about 7:1 for pierced parts. Ratios of about 9:1 are now possible, simply by changing the load pattern.

Instead of distributing the work done per pass fairly evenly, Commercial Shearing now makes a heavy first pass, follows it with a light second pass. Subsequent passes are normal. By doing most of the upsetting early while the material is still fairly soft, the larger ratios are obtained.

The company also reports it is working hard to extend the 3:1 ratio of length to diameter for rod stock in upsetting compression. Beyond this limit, most metals will buckle instead of mushrooming as desired. If current studies are successful, some sweeping changes will take place in the economics of upset forging.

It may be possible, according to company technical personnel, to upset forge auto axles in two passes, as against 4 or 5 passes at present.

Expandable foam sealer . . .

. . . in liquid form is the latest rubber-based adhesive product from Minnesota Mining and Manufacturing. By adding a heat-sensitive foaming agent to a liquid neoprene formulation, 3M has devised a sealer which can be squirted into difficult-to-reach voids and foamed-in-place to exclude moisture, dirt, or other possible contaminants on metal surfaces.

Unlike present prefoamed flat stock, which is thick and must be precut to fill known voids, the new sealer can fill uneven voids and will give way to spotwelding.

Also unveiled by 3M is a new water-dispersed contact-bond neoprene adhesive that should be of interest to applications using solvent-sensitive polystyrene foam.

Hotter firewalls . . .

. . . for aircraft are in the making with a new fabric developed by Raybestos-Manhattan. By coating asbestos fiber cloth with DuPont's Viton A elastomer instead of neoprene, R-M has upped the continuous-use temperature of its firewall material from just below 250 F to about 400 F.

Embrittlement of the asbestos fibers at 250 F has been the problem, but the higher temperature flexibility of Viton A keeps the embrittled fibers from breaking down under pressure fluctuations across the firewall.

Sintered mica . . .

. . . for parts that must take continuous temperatures to 1550 F is the latest development of Mycalex Corp. Designated Supermica 620, the new formulation is sintered in rod or plate form and machined to the configuration desired. Sintering gets away from the delaminating problems present in some mica products.

Used so far for missile parts like electrical connector lead insulators, Supermica 620 will take intermittent temperatures to 2000 F, can be machined faster than previous grades of mica-ceramics, and sells—in experimental quantities—for about $200 per cu in.

Welding aluminized steel . . .

. . . without destroying the corrosion protection of the aluminum coating has been a dilemma since the new materials first appeared. Spot-welding does the trick, if pressure tightness is not needed. Armco engineers have been suggesting stainless steel welding rod as the answer—even though many designers choke on the idea at first.

Welding with stainless rod under controlled conditions give a corrosion-resistant seam and little or no burn-back of the coating. Ordinary carbon steel rod can be used, but the burn-back is considerable and the weld zone has to be painted.

Fluid-pressure forming . . .

. . . for vinyl-clad steel cuts die costs and eliminates potential damage to the vinyl coating, according to US Steel experts at the Show. Displaying ex-

perimental parts drawn under fluid pressure by Hydroforming Corp of America, steel company engineers are optimistic about the process for parts requiring the deeper draws that tend to damage the coating when performed by more conventional processes.

US Steel markets a plastisol vinyl-clad steel in competition with metal that is clad with calendered vinyl sheet, adhesive-bonded in place.

Better wear resistance . . .

. . . . for tungsten carbide sintered parts is on the way with two new materials developed by Kennametal Inc. Designated K601 and K701, the two carbides are not as corrosion-resistant as K501—a platinum-bonded carbide.

In giving up some corrosion resistance, the two new binder-free carbides are lower in cost and have better wear resistance than K501 by a factor of about 5:1. K601 is nonmagnetic and is consequently being looked at closely for wear parts on magnetic devices like tape recorders and video tape equipment.

K701, while similar in wear-resistance to K601, has considerably less corrosion resistance—though its performance in corrosive environments is reported to be considerably better than most cast alloys and conventional carbides.

Foamed alumina . . .

. . . impregnated with epoxy resin has been developed by Electric Auto-Lite Co of Toledo. Stemming from a search for a new type of filter material, the foamed alumina can be shaped in the green state to the part configuration desired, fired and then impregnated.

Addition of the epoxy has the effect of raising the heat resistance of both component materials to a level high enough for possible ablation applications.

The search for filter techniques also led the company to ways of making thin (0.002-in.) filaments of alumina for possible weaving into cloth. Instead, it has been found possible to wind these filaments on a shaped mandrel, sinter them in place with a torch as the mandrel turns, resulting in a fired shape of precise dimensions.

This may solve the green-state sag problem experienced with large alumina shapes like missile nosecones. The new process is very much like filament winding of glass-reinforced plastic structures—a process widely used in missiles and aircraft.

Urethanes and sand . . .

. . . or alumina have teamed up to produce an unusual nonskid surface. The B B Chemical Co of Cambridge uses a polyester-type urethane prepolymer as a binder mixed with abrasive particles, and sprays the combination on many surfaces from hardboard to aluminum to get a colorful, roughened surface. Process is currently being used in Sweden to give a stonelike appearance to metal panel curtain-wall construction.

Adhesive-bonded diecastings

. . . reported as a new development in last year's Show report, are apparently headed for 1960's autos. One of the Big Three auto makers has reportedly specified an intake manifold made of three aluminum diecastings bonded together with epoxy-based adhesives. Advantages are said to be smoother interior surfaces, lighter weight, and—surprisingly, in view of the assembly steps needed—lower cost.

Flame-retardant laminates . . .

. . . for the 500-600 F range are very much in evidence, with emphasis being placed on paper-based epoxy systems. Many companies in the field report difficulty with punchability as a result of additives that give flame-retardent performance. In spite of heavy emphasis by laminators in this area, other fields are not being neglected.

For example, Synthane Corp is reportedly working on porous phenolic laminates suitable for oil-impregnation. Using linen reinforcing, these materials—now still in development—are intended for bushing and ballbearing applications where light weight and permanent lubrication are needed.

Dry adhesive film preforms . . .

. . . are a new wrinkle in the film adhesive field, being offered by Auburn Manufacturing Co. Using a 2-mil, supported epoxy film, Auburn die-cuts the shapes desired and supplies the preform with a backing paper lightly held in place by static electricity. Bond may be activated by either solvent action or heat and pressure, the latter giving the stronger joint.

Canadian inventors . . .

. . . in government-supported labs are getting a break in the expanded activities of a government-owned marketing company called Canadian Patents and Development Ltd. Organized in 1948, this concern takes advantage of Canadian patent law which makes government-owned patents freely available to anyone in the world who wants to exploit them. C P & D will license any qualified person or company to use or develop further patents which emerge from government-supported labs. Size of the fee depends on how much further development work is needed—the more the work, the lower the fee.

Key feature, however, is the exclusive nature of the agreement, which

Old-timer Still Going Strong

If time is to be the test for any material or product, perhaps the Lignum-Vitae Products Corp, Jersey City, should get an award for its manufacture of wooden bearings and gears. Of all the materials displayed at the Show, lignum vitae probably has been the longest used in its natural state.

When early sailing fleets roamed the world a sea captain could rest assured of one thing—he'd have no trouble with the lignum vitae bearings or pulleys. Although they may have been costly, they wouldn't split, wear, or burn out. The only trouble then and now was the expense. The lignum vitae tree grows in the tropics and when felled cannot be floated—it's too heavy. Roads had to be constructed into the jungles and crude rafts had to be built in order to get the heavy wood to port. Natives soon found that because of its cell structure, it couldn't be split. This made it an ideal material for ships' pulleys and water-lubricated bearings. Now, even with the progress of science, lignum vitae is still used aboard ships as well as for mallets, gears and even bowling balls.

encourages the licensee to put his own money and effort into further development, capital investment or sales.

A new nickel-plating process is a good example of the patents available. Plating rates of up to 750 amp per sq ft are claimed, making the process attractive for electro-forming as well as ordinary electroplating. A complete list of patents for licensing is available from C P & D, National Research Building, Sussex Drive, Ottawa.

Peen plating . . .

. . . combines peening and plating in a tumbling barrel in a new process from 3M. Also called impact plating the process is now limited to zinc coatings but will soon include aluminum. The technique tumbles parts in a barrel with metal powders and peening balls. Result is compaction of a controlled thickness of metal on the surface of the part at low cost with no hydrogen embrittlement.

High-strength columbium alloy . . .

. . . with 40,000-psi ultimate tensile at 2400 F has sufficient high-temperature oxidation for extrusion without protective "canning." This is one of several experimental columbium-base alloys announced by the Hayes Stellite Co and Union Carbide Metals Co. Although they can be hot-worked in air, with only a small weight loss from oxidation, they still require protective coatings for prolonged service at elevated temperatures.

H_2 embrittlement licked . . .

. . . that's the promise of a plating process for steel due soon from Battelle Memorial Institute. Process covers zinc and aluminum electroplates using normal baths, but avoids cathodic cleaning and acid etching.

Thermoset with a memory . . .

. . . under development by Lignum Vitae is now in field trials. A 4-in. ball deformed between flat plates to 3 in. (under 40 tons force) restored itself to within 0.004 in. The chemically inert material shows promise for bearings, bushing, structural applications.

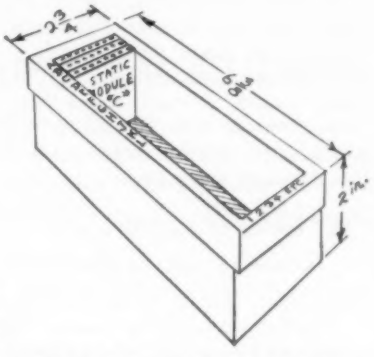
—Ford R Park, Herbert Kee

CONTROLS: ELECTRICAL AND FLUID

It was evident from the components exhibited that electronic, electrical and fluid controls are equally important in today's design.

Static-control modules . . .

. . . without bulky magnetic cores (dc circuits with resistors and transistors provide all the logic) were featured by Square D Company, Milwaukee. Wafer-type construction of the elements in back of each terminal reduces the over-all size greatly, compared with conventional magnetic-type static modules. Also, response is faster; rates to 25,000 per second are possible.

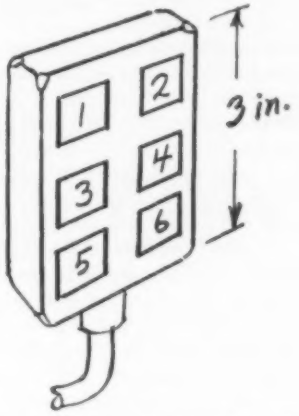


The partial assembly (sketch) shows construction only; an actual device can have 21 modules, each with 10 female terminals along the top. First module is connected to the dc power supply and energizes the remaining modules. Each of the others is a NOR-logic element and has a PNP transistor in a common-emitter circuit as a switching element. Input points are tied to the transistor base through current-limiting resistors. An output terminal is connected to the transistor collector. When the transistor base current is high, voltage drop between emitter and collector is very low, corresponding to a closed switch. When an input is absent, a small positive bias voltage, connected between base and emitter, maintains the transistor in the nonconducting state. This bias is stable at ambients up to 60°C.

Other logic functions, such as AND, OR, NOT, MEMORY, can be obtained by combining NOR elements. The new static module pack will be available as a component and is adaptable to any logic system, including machine-tool control and computers.

Hand-held controller . . .

. . . operates on 4 volts and has non-snap contacts. Made by Franklin Electric, control was originally designed for automatic hospital beds. Transistorized amplifiers in a separate chassis increase the 4 volts to 24 to operate normal relays and solenoids. Simple circuitry is claimed possible



by manufacturer because their standard motor, Inst-o-Verse, has built-in reversing switch that is automatically preset by rotation of shaft. A safety feature is the complete separation of the 115-v motor circuit from the 4-v controller.

Submersible motors . . .

. . . also made by Franklin Electric, use water instead of oil for lubrication. Plastic-embedded stator windings, stainless steel inner lining, and a filter checkvalve at bottom insure that the lubricating water stays in the motor. It is designed for swimming pools.

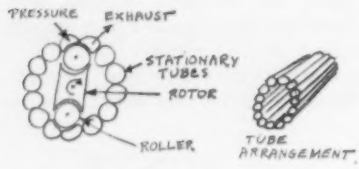
Accordion-type terminals . . .

. . . developed by Heyman Manufacturing Co, Kenilworth, NJ, can replace bolted-in terminal boards for electric motors. The rectangular bushings, made of nylon, can be snapped into position in rectangular openings cut in the sheetmetal motor housing, and easily conform to the curvature. The bushings are available in single or connected groups of up to five

units, and can be flexed in both concave and convex directions.

Novel air motor . . .

. . . has no vanes, pistons or gears, yet gives infinitely variable speeds from 0 to 5000 rpm. It had first public showing here by Humphrey Products Div of General Gas Light Company. Section view gives principles of



operation but does not show the air distributor plate—attached to rotor—necessary to pressurize and exhaust the flexible tubes. High starting torque is possible at any angular position of rotor. Speed and direction of rotation are controlled by adjusting the distributor valve plate and by regulating the air supply pressure. Other fluids, including oil, will operate this motor.

Constant speed can be maintained under varying loads, but a governing system must first be developed to automatically adjust air supply pressure as well as distributor valve plate position. Such a speed-control arrangement will give the most efficient operation.

The motor is not yet available for purchase, but the manufacturer claims that efficiency will be greater than that for other air-motor designs. This performance is predicted: ¾ hp from output shaft at 500 rpm with 24-cfm air at 100 psi, with a motor diameter about 3 in. and a length about 1 ft. Possible applications include air tools and hoists.

Building-block hydraulic servos . . .

. . . are now available as standard preengineered components from Vickers, Inc, Machinery Hydraulics Div. And $3000 will buy a complete system consisting of: a hydraulic power package with tank, pump and accessories; an electrohydraulic servovalve integrated with a piston-type hydraulic motor to drive output shaft; and an electronic unit to amplify input and feedback signals to the servo. System demonstrated at the Show was velocity-controlled from 0 to 4400 rpm and it developed 20 hp; but other designs can give higher hp using servopumps. A position-control package—using a cylinder or hydraulic motor—is also available. Additional styles contemplated are for constant hp and constant tension.

Response to an input signal can occur as fast as 1/100 sec for a 50 lb-in² inertia load on 20 hp servo system such as the one demonstrated. Linearity will be plus-or-minus 2 rpm, and full torque can be developed at all speeds down to 1 rpm. It is predicted that a position control using a hydraulic motor will be accurate to seconds of arc; and a constant-hp version will vary in power less than 5% of rated load.

A likely market for such servo systems is in machine tools; a packaged unit can be almost directly applied, and trimming adjustments can be made quickly. Vickers hopes that small companies will buy models for experimental and educational reasons, thus increasing understanding.

"PL" factor of 12,000 . . .

. . . for stacked hydraulic gear pumps is reported for a design made by Commercial Shearing and Stamping Company. The "PL" relation is this: pressure X gear width X number of gear pairs must not exceed 12,000. For example, four pumps, each with 3-in.-wide gears (L is 4 x 3) cannot be run at pressures exceeding 1000 psi. Max pressure limit for stacked pumps of this design is 2000 psi.

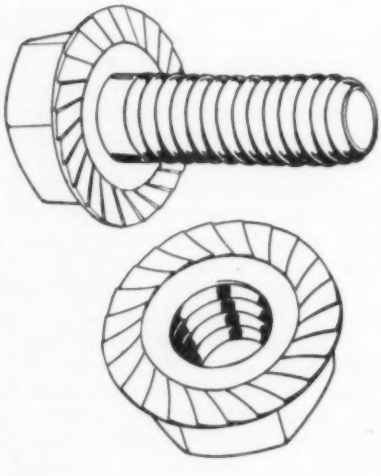
Liquid-level controls . . .

. . . made originally for washing machines may soon invade other industrial markets, reports director of engineering for Controls Company of America, Schiller Park, Ill. A simple pressure switch, operated by a volume of trapped air, provides the control signal. It works like this: An inverted, open cup is mounted in the tank; a length of tubing connects the top of the cup to the diaphragm of the switch; and the rising liquid in the tank compresses the air trapped in the cup and tubing. One of the main problems will be to strengthen the existing device to mechanically withstand more severe industrial usage. The switch can be any distance from sensing chamber.

—Frank D Yeaple

NEW FASTENING METHODS

Faster installation, design for use of automatic feeding, and several new materials brought a number of new ideas about fastening to those visiting the Show.



Locking nuts and screws . . .

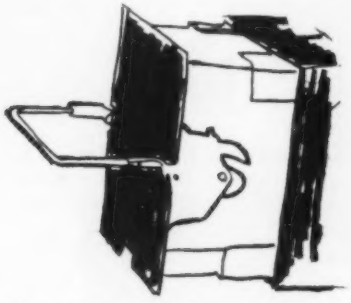
. . . that require more torque to remove than put on are offered by MacLean-Fogg Lock Nut Co, Chicago 40. Key to their locking action is the toothed, slightly tapered surface provided on the flats. Nuts and screws are made in sizes from No. 6 to ⅜ in. with hex or round flanged heads.

Molded Delrin plastic fasteners . . .

. . . are being offered commercially for the first time by Gries Reproducer Corp, New Rochelle, NY. Company displayed locknuts and couplings, says other types of fasteners can be made to specifications. Primary advantages of the material: strength, stiffness, and creep resistance. (For more on this new material, see *PE—Sep 29 '58, p 36.*)

One-hand latching device . . .

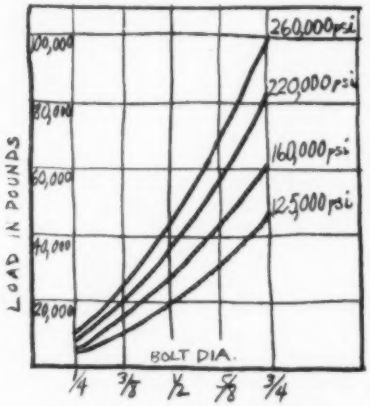
. . . that will jack a module out of its chassis and disconnect electrical contacts at the same time has been de-



veloped by South Chester Corp, Lester, Penna. Specifically designed for electronic equipment, it's expected to find other applications as well.

High-strength bolts . . .

. . . in sizes to 1¼ in. dia offer tensile strengths as high as 260,000 psi—an increase of 40,000 psi over the strong-



est previously offered (note chart). Standard Pressed Steel Co, Jenkintown, Penna, makes them, is also offering new swage nuts that can be anchored in sheet metal in thicknesses down to 0.020 in. and hardnesses to Rockwell C 25 "with installation pressures up to 50 per cent lower" than previously required.

Double-ended eyelets . . .

. . . in sizes down to 0.060-in. hole dia are now being made by United Carr Fastener Corp, Cambridge 42, Mass. The company believes they're the smallest double-ended types ever offered commercially.

High-strength adhesives . . .

. . . in film form are offered by Minnesota Mining & Mfg Co, St Paul 6. These are designed for structural use on metal-to-metal assemblies; are said to increase part life as much as 90% as compared to standard fastening methods.

Self-drilling screw . . .

. . . is case hardened, has a tapered "gimlet" point and Frearson slotted head, can be driven in sheet steel with hand power tools. Developed by Reed & Prince, Worcerter, Mass, screws are currently available in sizes from No. 2 to No. 10 with flat head and round head. Maximum thickness of sheet increases with screw-size—from 0.025 in. with No. 4, to ⅛ in. with No. 8.

Miniature socket-head screws . . .

. . . in flat head and button head, were announced by Bristol in sizes from No. 3 down to No. 0, in three stock lengths for each size. Screws are supplied with either hex or multiple spline sockets; class 3A fit is standard. These are additions to the existing line of miniature socket-head cap screws and setscrews. —A. R. Gardner

ENGINEERING DEPARTMENT EQUIPMENT

Comfort in the drafting room, a commodity that hasn't been too saleable in the past, is showing up in much of the new drafting equipment. The trend combines the comfort and prestige of a desk with the functional qualities of a drawing table.

Adjustable drafting boards . . .

. . . bring every point on a large drawing within easy reach of the draftsman. In addition to the domestic products, two imported models were on display (from France—the Unic, distributed by Stacor Equipment Co, Newark, NJ; from Germany—the Nestler, imported by Ozalid Div of General Aniline & Film Corp, Johnson City, NY). Both imports use a counterbalanced parallelogram linkage controlled by footpedal locks to allow movement to any angle or any height. Stacor is also manufacturing its own drafting board, introduced at the show, which has an adjustment mechanism patterned after the Unic but includes a built-in reference table —either at the side or rear.

Another newly introduced drawing board with the quick-adjust feature was displayed by Standard Pressed Steel Co, Jenkintown, Penna. This Emmert-designed board moves through a 75° arc, has 10-in. radial travel, is cam-locked into place by levers behind the board. It comes with an attached reference desk to make an L-shape module. The Emmert drafting machine, an X-Y track-type device shown with the board, has been improved by removing the small nylon wheels which previously rolled over the surface of the drawing, leaving a smudgy track.

Two new tables . . .

. . . were shown by Hamilton Manufacturing Co, Two Rivers, Wis, in addition to its adjustable Auto-Shift table. One is a walnut-faced modular unit (without Auto-Shift feature) designed to harmonize with modern furniture in home or office. The other: a take-apart table built out of two filing cabinets and a drawing board, intended for engineering departments which fluctuate in size depending on workload. When fewer draftsmen are at work, the extra boards can be stored away and the filing cabinets stacked for additional drawer space.

Another viewpoint in the controversy—"which working position is most comfortable for the draftsman"—comes from General Fireproofing Co, Youngstown, Ohio. While most drawing-board manufacturers believe height and angle of work should be quickly adjustable to avoid fatigue which results from working too long in one position, General Fireproofing thinks draftsman's comfort depends upon the chair heights and angle of the board—there is one most-comfort-

able position each draftsman finds for himself by trial and error. On this premise, GF has designed a drawing board in which the angle is adjusted by a screw jack and the drawing is taped to a continuous vinyl belt the width of the board, with rollers at the top and bottom. A twist of a knob rolls the top of the drawing down to the bottom of the board.

Mechanical mockups . . .

. . . Overseas Commodox, Inc, Detroit, reports increased interest in its FAC construction kits–the Swedish-made erector-sets-for-engineers. The import firm lists over 75 American firms that have purchased the kits–some firms have bought several. Among those on the list: General Electric, DuPont, IBM, Battelle Memorial Institute, Bell Telephone Labs. FAC claims the 150 basic elements can be used to build working models of almost any kind of mechanism, machine or structure–from an automobile chassis to a punch press. Large kit (4700 pieces) sells for $400; small kit, $250.

Temperature programming . . .

. . . is as simple as drawing a line on a paper, according to Research Inc, Hopkins, Minn. Its new recorder-programmer looks like a conventional pen chart recorder. But the program is plotted directly on the chart paper. No cams need be cut. Just draw two parallel lines on the circular chart about ⅛ in. apart, with an ordinary pencil. Plot the lines to give the desired time-temperature pattern. When the chart is put on the recorder a sensing head in the recording pen keeps the pen between the two lines, automatically cycling the furnace according to the penciled program.

Dynamic torque measurements

. . . can be made without imposing additional loads on the system, with a new torquemeter developed by Metron Instrument Co, Denver. The pickup head has input and output shafts which are coupled directly into the drive line of the system being tested. Inside the head, shafts are allowed to twist relative to each other through a small torsion bar link. Relative displacement of shafts is sensed by a light-chopping device. Signals from pickup head are read with an accuracy of 2% on a large, linear dc meter which deflects upscale regardless of shaft rotation. Measures torques at speeds from 50 to 12,000 rpm and instruments are available with full scale reading from 0-5 oz-in. to 0-250 oz-in. Price $935,000. **–Charles J Lynch**

CATALOGS and HANDOUTS

Refresher booklet printed especially for Show visitors by Fenwal Inc of Ashland, Mass, presented highlights of the booth products on display, and a handy postcard for those gentlemen who "forgot to remember" to ask for information at the Show. . . . . Comprehensive socket-screw calculator distributed by Standard Pressed Steel Co, Jenkintown, Penna, spotlights dimensions in individual windows. Also contains decimal-equivalents table for wire letter and fractional size drills. . . . About 100 pp of engineering information, dimensions and capacities for a variety of standard and special roller bearings is offered in new Engineering Manual SF-90 from Roller Bearing Co of America, West Trenton, NJ. . . . W G Wilkins, president of Universal Castings Corp, 5821 W 66th St, Chicago 38, is the author of a new brochure on plaster-mold castings. Discusses selection of materials, processes and design conisderations.. . . . Engineers queued up at the Stow Mfg Co booth to sign up for a free torques calculator, which serves beyond its original intended use with flexible shafting. This ever-popular calculator can be had from the Binghamton, NY firm.**–P B Sweed**

AN INDUSTRIAL DESIGNER SAW THIS

"I found a dozen candidates at the Show for the article I am preparing on the OEM products that were displayed. But I am impressed that only two of the items had even been worked on by industrial designers."

This critical comment is from Joseph Carreiro, head of the Industrial Design Dept of the Philadelphia Museum College of Art and also senior partner of Carreiro Design Associates. Mr. Carreiro's article will appear as the regular "Trends in Appearance Design."

"As for the Show as a whole," says Mr. Carreiro, "I am afraid that the design quality of the various exhibits was in most cases much higher than that of the products displayed in them. Too often the product-design engineer is asked to style a product only after he has succeeded in fulfilling management's requirements as to function and despite the fact that he has had none of the required training and experience in industrial design."

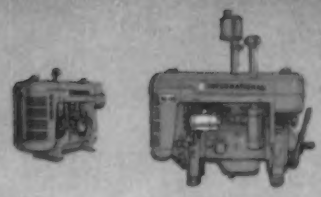
And yet, he points out, today's design engineer "has a rich, almost unlimited selection of materials to choose from–in fact, variety exists to the point of confusion."

Mr. Carreiro, together with his junior partner, Mr. William Sklaroff, did finally select 11 products on display at the Show for their superior appearance-design qualities. Included were power-transmission units, electrical, pneumatic, and hydraulic components, lubrication equipment. Our next week's issue will evaluate their strong and weak points, as well as show what they look like. **–John Kolb**

Thank You

We were both gratified and overwhelmed by the number of readers who stopped by at our Design Show booth to become acquainted, make suggestions, or compliment us on recent issues. In several instances, however, we were unable to greet visitors because editors were already engaged or were elsewhere in the show digging out the information you find in this exclusive report. To those readers we sincerely apologize. And we'll see you next year, if not sooner. –EJT

CIRCLE 125 READER SERVICE CARD→



UC-60
16.5 max. eng. hp

UC-135
42 max. eng. hp

UC-221
75 max. eng. hp

UB-220
83 max. eng. hp

U-308
92 max. eng. hp

UC-2
95 m

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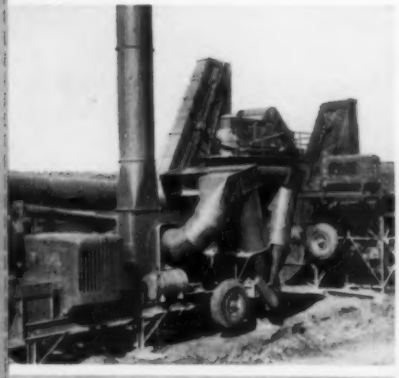
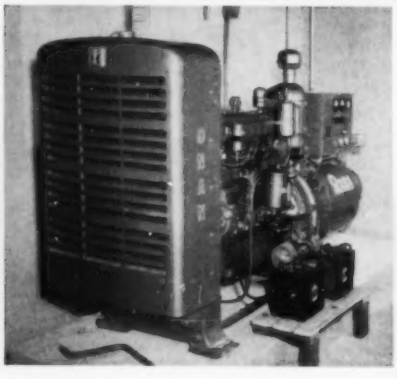
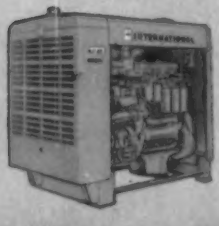
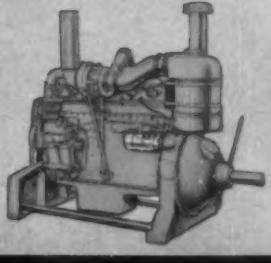




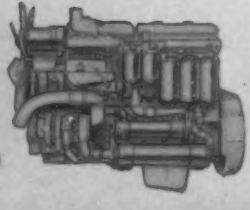
UDT-817
375 int. eng. hp



UDT-1091
265 int. eng. hp

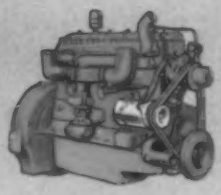


UD-817
240 int. eng. hp



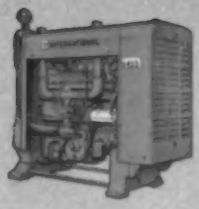
UD-1091
216 int. eng. hp

UC-263
95 max. eng. hp

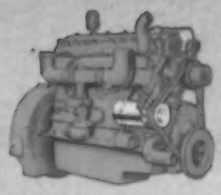


U-372
110 max. eng. hp

UB-264
112 max. eng. hp



U-450
134.5 max. eng. hp



U-501
141 max. eng. hp

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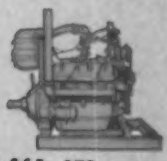
Your request for more specific information or installation assistance will get immediate attention. Just write or call International Harvester Co., Engine Sales Dept., Construction Equipment Division, Melrose Park, Ill.

UV-401—170 max. eng. hp



UV-461—179 max. eng. hp

UV-549—222 max. eng. hp

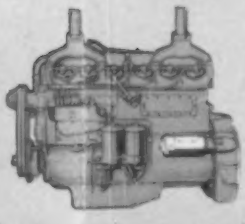
U-1091—248 max. eng. hp
(nat. gas)

CARBURETED

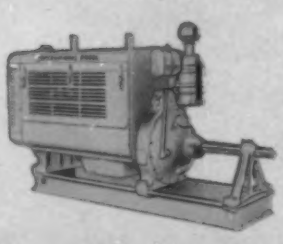
DIESEL

UD-236—70 int. eng. hp

UD-554
140 int. eng. hp

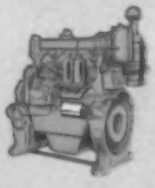


UD-18A
131.5 int. eng. hp



UD-14A
105 int. eng. hp

UD-370
95 int. eng. hp



UD-282
90 int. eng. hp

V-8's

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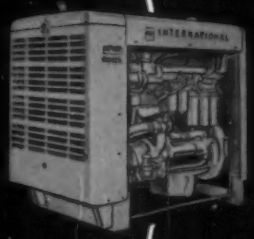
24 engines
featuring



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Power

4's

16.5 to 385 hp diesel and carbureted

Your choice of engine sizes and fuels, all with *Fastest Payback Power*

Your International Power Selector

CARBURETED	MODEL	RATED RPM	CU. IN. DISPLACEMENT	GASO. HP	LPG HP	NAT. GAS HP
FOURS	UC-60	2500	60	16.8		
	UC-135	2000	135	42	42	32
	UC-221	2400	221	75	75	66
	UB-220		220	83	83	70
SIXES	U-308	2400	308	92	96	82.5
	UC-263	2400	263	95	95	85
	U-372	2200	372	110	101	92.5
	UB-264		264	112	112	90
	U-450	2200	450	134.5	130.5	112
	U-501	2200	501	141	134	120
V-EIGHTS	UV-401	2800	401	170	165	142
	UV-461	2600	461	179	175	162
	UV-549	2600	549	222	215	192

DIESEL	MODEL	RATED RPM	CU. IN. DISPLACEMENT	MAX. TORQUE AND RPM	BORE X STROKE IN.	INTERMITTENT HP
FOURS	UD-370	2200	370	262 @ 1400	4⅝ x 5½	95
	UD-14A	1800	460.7	325 @ 900	4¾ x 6½	105
	UD-236	2400	236	173 @ 1800	$3^{11}/_{16}$ x $3^{11}/_{16}$	70
	UD-282	2400	282	217 @ 1800	$3^{11}/_{16}$ x 4.39	90
	UD-554	2300	554	400 @ 1300	4⅝ x 5½	140
SIXES	UD-18A	1600	691.1	473 @ 850	4¾ x 6½	131.5
	UD-1091	1500	1090.6	825 @ 1150	5¾ x 7	216
	UDT-1091	1500	1090.6	1000 @ 1250	5¾ x 7	265
	UD-817	2100	817	638 @ 1600	5⅜ x 6	240
	UDT-817	2100	817	1052 @ 1200	5⅜ x 6	375

NOTE: *For carbureted engines use 90% of max. hp shown for intermittent type application and 80% of max. hp for continuous type application. For diesel engines use 80% of intermittent hp shown for continuous duty application.*

Specifications subject to change without notice.

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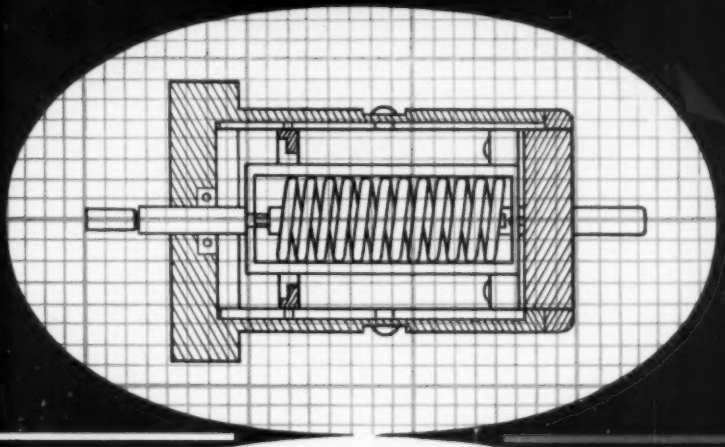

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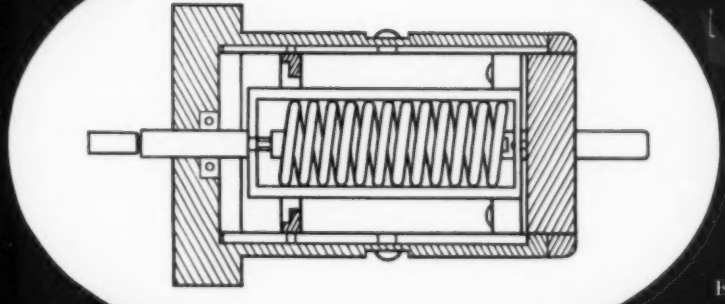

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Permanence is a virtue of Porcelain Enamel greatly appreciated by users of products made with this material. It withstands aging, weathering, corrosion, abrasion and abuse better than any other finish. Long life is an added sales point Porcelain Enamel can give your products.

WIDE RANGE OF TEXTURES AND PATTERNS

The many attractive textures and patterns available in Porcelain Enamel give further opportunities to develop interesting designs. Many beautiful standard textures are available, and special ones can be developed. And the embossing or corrugating process makes the material stronger and more rigid!

—AND EXCELLENT PHYSICAL AND CHEMICAL PROPERTIES

In addition to beauty and color, Porcelain Enamel provides many very useful engineering properties. It is glass-hard, steel-strong, and resistant to alcohol, chemicals, gases, moisture, flame, sunlight, thermal shock, abrasion, aging. Porcelain Enamel has a low coefficient of friction and high dielectric strength.

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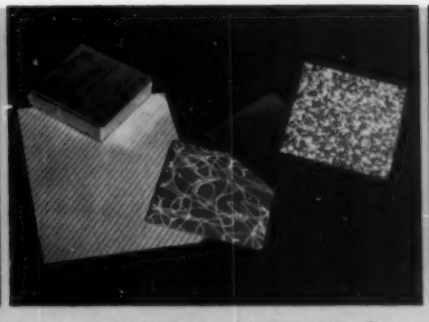
INTERESTING EFFECTS, obtained with textured or patterned Porcelain Enamel, add greatly to the salability of many products. Corrugated and expanded metal are effective when finished with Porcelain Enamel.



COLORFUL PATTERNS give an endless array of designs that may be functional or decorative. Wood-grain and marble designs, pebbled and embossed surfaces give the designer wide latitude.

REFLECTIONS in these photographs show the difference between a highly glossy surface (left), semi-matte (center) and full matte. All are readily available in Porcelain Enamel.

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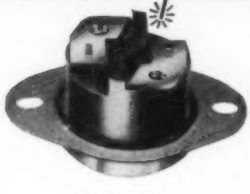
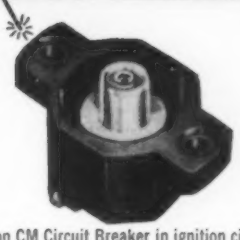


Klixon 20220 sealed control thermostat, for mounting directly on the tubing through which cooling liquid passes.

Klixon 20200 Thermostat shuts off ignition current when burner flame ignition is achieved.



Klixon CM Circuit Breaker in ignition circuit is a safety device to shut off the complete unit if burner flame does not ignite.

KLIXON *Snap-Action Thermostats Can Take the Beating of Shock and Vibration in E. P. Engine Heaters... And in Your Product, Too*

Designers at Engineering Products of Canada Limited needed thermostats and circuit breakers that are rugged and perform reliably under the beating of road shock and vibration in the face of temperature conditions down to minus 45°F. For use on all types of vehicle engines, their "sure start" propane fired heaters for engine cooling system warm-up called for "sure thing" temperature control and operational dependability. That's the reason KLIXON Thermostats and Circuit Breakers were selected, and here's what Mr. Bernard Champoux, Engineer, says about them:

"The performance of the thermostats and the circuit breaker is very good, even under the very rugged condition of our heater being installed on bulldozers where the controls are completely exposed to outside weather. The performance is exactly as it was expected to be providing dependable operation and safety."

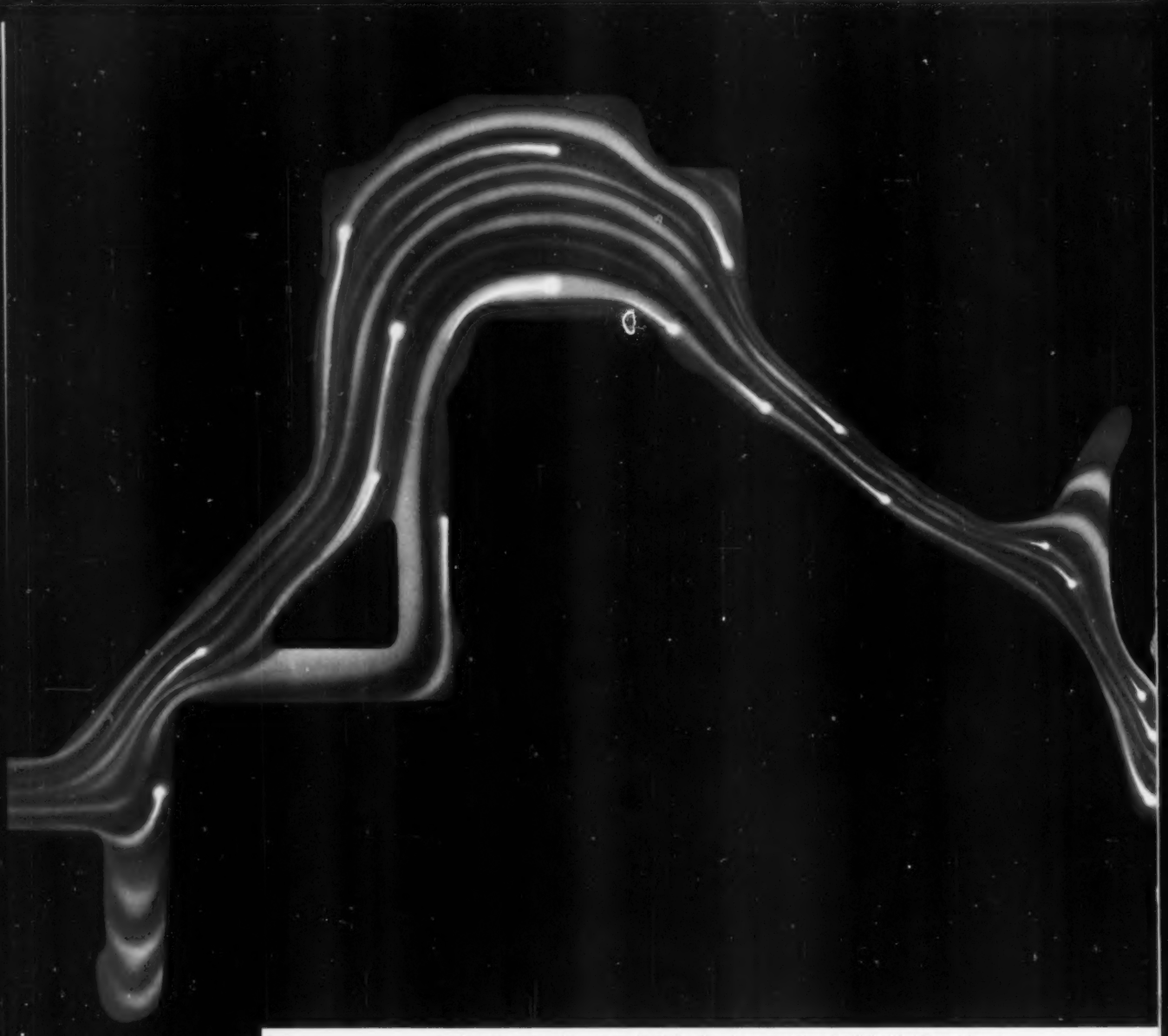
Have you an application requiring "sure thing" temperature controls? If so, do as so many manufacturers of all types of equipment are doing — get the same dependable performance — by specifying and using KLIXON Controls. Write for Technical Data Bulletins.

METALS & CONTROLS

3806 N. MAIN ST., VERSAILLES, KY.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

VERSAILLES PRODUCTS: Klixon® and Ampli-Tube® Thermostats



Fluid mapper pattern demonstrating liquid flow through a cross section of a Malleable differential carrier.

Versatility is Malleable

The ability to do most any job well is synonymous with Malleable iron castings. The variety of tasks they perform, from the commonplace to the spectacular, is legend. The strength and toughness . . . the freedom of design . . . the wide range of shapes and sizes . . . the excellent machinability . . . the economies achieved . . . all these advantages of Malleable combine to create an unexcelled reputation for versatility.

Whatever your needs, look first to Malleable.

For information or service, call on one of the progressive firms that identify themselves with this symbol—

MEMBER
MALLEABLE
CASTINGS COUNCIL

If you wish, you may inquire direct to the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, for information.

Versatility Is Key to Malleable's Increasing Use

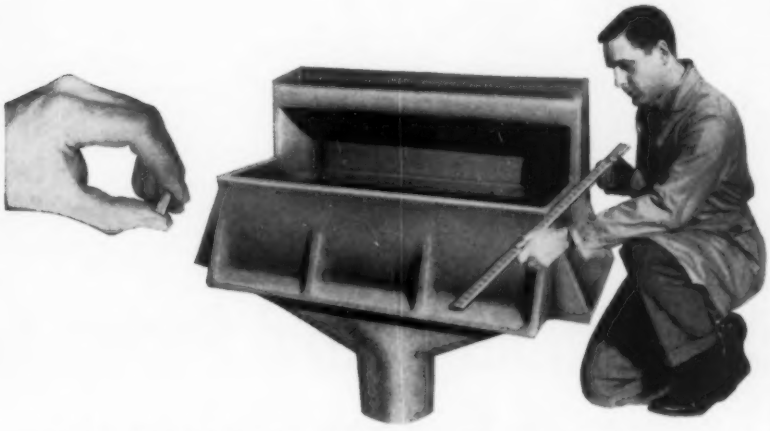
Recent metallurgical advances have made the Malleable irons a family of metals uniquely capable of meeting the most diverse design, production and performance requirements. Whether the vital consideration is high strength, toughness, ductility, hardness, machinability, high or low temperature performance, wear resistance, or economy and adaptability for complicated designs, Malleable castings have the versatility to meet exacting specifications.

For versatility of shape, the casting process is unexcelled. It permits direct production of the most complicated components. The metal is placed exactly where it is needed regardless of the intricacy of the design.

The capabilities of the metal to be cast are of even greater significance, for every application has a different set of requirements. Here, Malleable iron provides unique opportunities to obtain better parts at less cost.

Holes can be punched in Malleable, surfaces can be coined to meet rigid specifications. The pearlitic Malleables can be surface-hardened for even better wear resistance. These and other advantages make today's Malleable iron one of the most versatile engineering materials available.

Although Malleable iron's properties are flexible, depending on service requirements, certain relationships remain constant. Malleable provides more strength and toughness per dollar than any other metal. It is also the most machinable of all ferrous metals of similar properties.



Malleable castings can be produced in sizes ranging from the hammer handle wedge, shown here, weighing less than an ounce, to the 1,125 pound bridge scupper. Throughout this range is an endless variety of castings, best made of Malleable for highest quality at lowest cost.

Shapes and sizes of Malleable castings are virtually limitless. The combination of Malleable's good castability with modern production techniques regularly results in sections as thin as 1/16" and tolerances of ±.005" per inch in sections of 1", with excellent surface finishes.

Engineering Aids Available

While the design of Malleable castings is not complicated, it will pay you to consult a skilled Malleable engineer who can offer time and cost saving suggestions for the production of better parts. As another aid to basic Malleable casting design, a special folder — *Data Unit 104 — Design Versatility* — is available from any member of the Malleable Castings Council and from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
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Laconia Malleable Iron Co., Laconia

NEW JERSEY
Meeker Foundry Company, Newark 4

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Badger Malleable & Mfg. Co., S. Milwaukee
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

CIRCLE 130 READER SERVICE CARD

In providing a secure, easily interchangeable attachment for Gravely rotary cultivators, Republic Nylok Studs are inserted into the adapter shown at left. The cultivator unit is then placed in position over studs, and nuts are applied, holding cultivator firmly in place. Republic Nylok Fasteners hold securely even under shocks from hidden stones, and vibration from the severe churning action of cultivator blades.

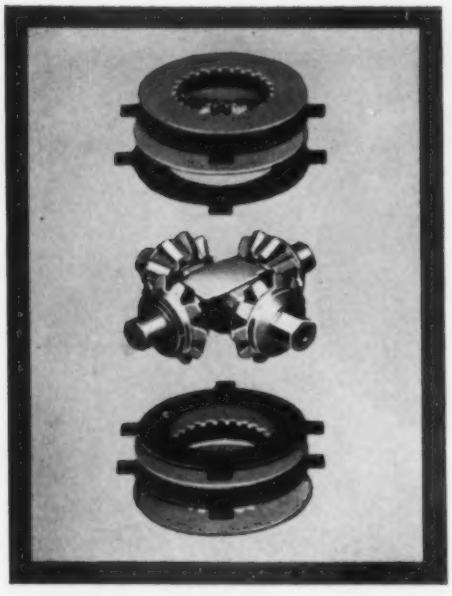
Republic Nylok® Fasteners Hold Securely Even Under Shocks of Rotary Cultivation

Finding a dependable fastening method for tractor-attached rotary cultivators presented a real challenge to Gravely Tractors, Inc., Dunbar, West Virginia. A fastener had to be found that would hold securely and give long, dependable service under the constant shocks and pounding of rotary cultivating. To meet these requirements, the company chose Republic Nylok Studs.

Republic Nylok Fasteners have a special nylon insert that assures positive locking at any position, even under severe shock, vibration, or tension. When the fastener is assembled, this nylon plug exerts pressure in a lateral direction, preventing all play, and utilizing the metal-to-metal contact of the opposing threads for locking.

Republic Nylok Fasteners provide maximum holding power under all conditions, whether seated or not; and they can be used repeatedly. One of their unique advantages is the "plastic memory" of the nylon plug—the tendency of the nylon to recover its original shape after assembly. This "growth" into the threads actually results in a tighter locking action, after a period of time, than when the fastener was first assembled.

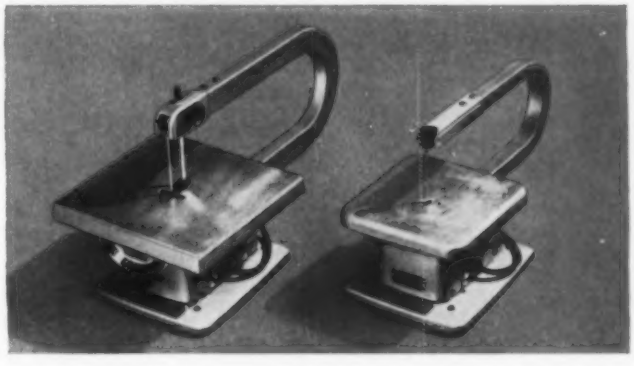
The nylon insert is unaffected by age or cold, has high resistance to heat, and very low moisture-absorption rate. These are but a few of the advantages which led Gravely Tractors, Inc., to use Republic Nylok Fasteners on their advanced line of rotary cultivators. These and other advantages can pay dividends in *your* application, too. For full information, contact your Republic representative, or mail coupon.



SUPER TOUGHNESS AND STRENGTH at critical points are provided by Republic Alloy Steels in the Powr-Lok Differential developed by Dana Corporation, Toledo, Ohio. Dana engineers have reduced the possibility of mechanical breakdown in clutch rings and side gears by forging these parts from Republic Hot Rolled 8615 Alloy Bars. This fine steel withstands torque, fatique, shock, and stress, and makes possible maximum resistance to abrasion, friction, and wear. An exceptionally high strength-to-weight ratio permits the designing of thinner sections. For further facts, send coupon.

ECONOMY WITH CORROSION-RESISTANCE is provided by Republic Galvannealed Sheets, used by Air Conditioning and Drying Division, Surface Combustion Corporation, Toledo, Ohio, in making KATHABAR® Dehumidification Systems. In these units Galvannealed Sheets help solve corrosion problems. And their tight, uniform zinc coating will take all ordinary forming operations. Shear, blank, pierce, form, flange, solder, deep draw, or bead them with ease. For more information on Republic Galvannealed Sheets, mail coupon now.

SAVINGS IN TIME AND MATERIALS are realized by Syncro Corporation, Oxford, Michigan, by using Republic ELECTRUNITE® Mechanical Tubing in the manufacture of jigsaws. Previously they used a casting for the blade-yoke, which requires a severe bend. ELECTRUNITE Square Tubing was recommended for one model, rectangular tubing for the other. Results: reduction in weight of the blade-yoke, and improvement in appearance of the product, with savings in time, materials, assembly, and shipping costs. For more information on Republic ELECTRUNITE Mechanical Tubing, mail coupon below.



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- ☐ Nylok Fasteners
- ☐ Galvannealed Sheets
- ☐ Republic Alloy Steels
- ☐ ELECTRUNITE Mechanical Tubing

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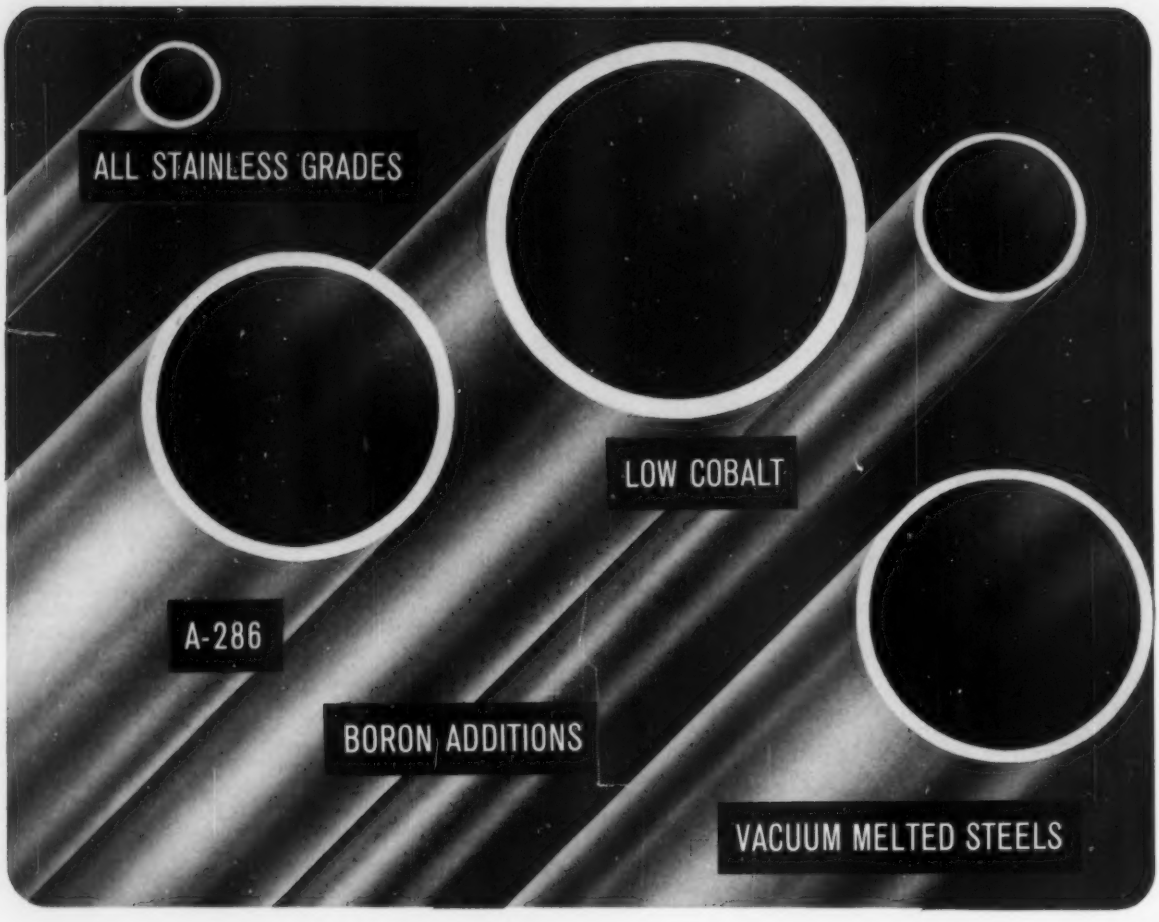
Experience *— the added alloy in* ***Allegheny Stainless***



What are your needs in Seamless Tubing?

A-L offers widest range of materials and large diameters with walls as thin as .032".

Here is the widest range in materials in stainless seamless tubing available anywhere to meet your exact requirements and solve high-temperature or corrosion problems and save you money.

Allegheny Ludlum makes seamless tubing in all stainless grades including 309, 317, 318, 310, 416 and 446—normally difficult to obtain. Also available in high-strength alloys such as A-286, in vacuum melted steels, and in custom analyses grades such as low cobalt with .01 or .05 max. and small boron additions to standard types.

A-L also makes composite tubes with bonded combinations of carbon and stainless and other metals for special chlorine-corrosion applications in process equipment.

Allegheny Ludlum Stainless Tubing ranges from 3/16" OD to 3½" OD with wall thickness ranging from .013" to .375"—typical of the sizes that A-L can produce. For certain applications, .500" walls are possible. Some standard sizes in stock are 2½" OD—.032" walls, 3" OD—.042" walls and 3½" OD—.042" walls and 3½" OD—.058" walls. All sizes with true circularity, no dents or handling marks.

A-L Tubing is also available in small quantity orders, in random or cut lengths. Standard grades and sizes in stock throughout the country. Call your nearest A-L representative for all the help you need.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept. PE-18.

NEW! FREE—Write for your copy of Allegheny Ludlum Stainless Tubing—32-pages of technical data, grades and suggested applications.

WSW 7829

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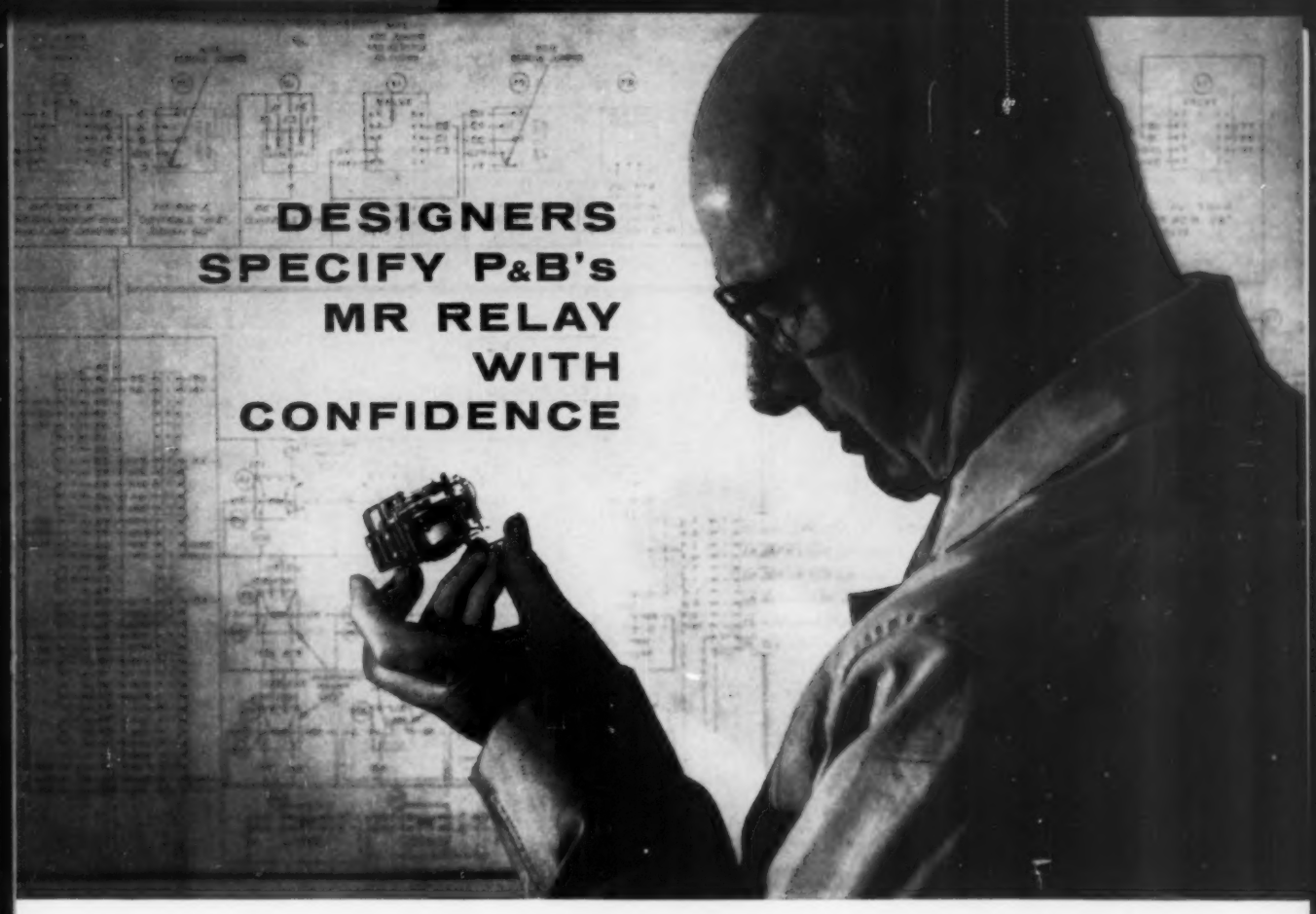
EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT



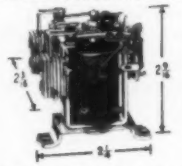
for a host of control applications

RELIABILITY coupled with low cost are two factors which place the MR series relays high on P&B's best seller list. They are being used in a multiplicity of designs . . . transmitters, street lighting equipment and small motor starters, to name but a few.

Both AC and DC models are available, with AC coils ranging up to 440 volts. All are adaptable for printed circuit mounting. The wide variety of contact arrangements include:

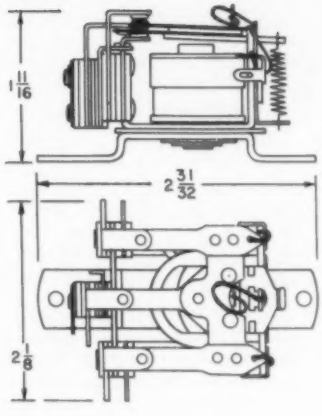
SPST-NO	SPST-NC-DB	DPST-NC	3PST-NC
SPST-NC	SPDT	DPDT	3PDT
SPST-NO-DB	DPST-NO	3PST-NO	

For more information about this medium duty, compact relay, call or write today—or get in touch with the P&B sales engineer nearest you. See our complete catalog in Sweet's Product Design File.



LM SERIES: Plate circuit relays similar to the MR. All sp and dp contact arrangements shown above are available. Coils are wound to specified resistances up to 58,000 ohms max. Sensitivity ranges from 15 mw min. (single pole) to 70 mw min. (double pole).

MR SERIES



GENERAL SPECIFICATIONS:

Breakdown: 1500 volts, 60 cycle rms between all elements.

Temperature Range:
DC —55°C. to +85°C.
AC —55°C. to +75°C.

Pull-in: Approx. 75% of nominal dc voltage; 78% of nominal ac voltage.

Weight: 4 ozs.

Dimensions: 2 31/32" long x 2 1/16" wide x 2" high.

Mounting: Two 9/32" dia. holes. Can be adapted for printed circuits.

CONTACTS:

Arrangements: Up to 3pdt.

Material: 7/32" dia. silver. (Others available).

Load: 8 amps @ 115 volts, 60 cycle, resistive.

COIL:

Max. Resistance: 34,500 ohms.

Power: 1.5 watts dc; 3.25 volt-amps ac. Will withstand up to 6 watts at 25°C.

Voltages: Up to 110 volts dc; up to 440 volts 60 cycle ac.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

POTTER & BRUMFIELD INC.

PRINCETON, INDIANA • SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

IN CANADA: POTTER & BRUMFIELD CANADA, LTD., GUELPH, ONTARIO

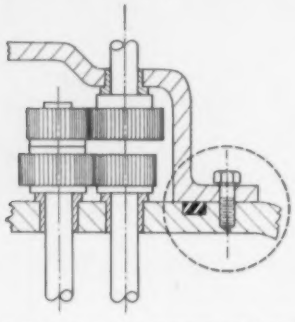
CIRCLE 133 READER SERVICE CARD

Technical data for gasket design and selection

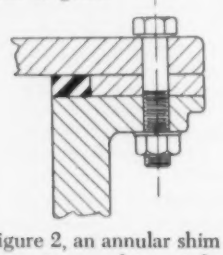
Effective sealing with confined gaskets

To seal a metal-to-metal joint effectively, a gasket must completely fill the gasket channel to provide maximum contact with the mating flange . . . and it must compress enough to prevent leakage of the sealed medium.

With truly compressible materials, such as cork-and-rubber composition, gaskets are cut to full channel width, and from 1.25 to 1.5 times channel depth. No relief for sideflow is needed, and close tolerances for gasket and metal are unnecessary.



In Figure 1, the instrument housing flange employs a completely confined cork-and-rubber gasket that prevents lubricant leakage and permits perfect alignment of gears.



In Figure 2, an annular shim adapts flat flanges to metal-to-metal sealing. Cork-and-rubber gasket compresses to form a tight seal without flowing out.

Send for a copy of the new Armstrong Gasket Design Manual. Write on your business letterhead to Armstrong Cork Company, 7106 Irvin Street, Lancaster, Pennsylvania.

Engineering research on aluminum flanges shows how bolt torque loss can be reduced

Alternate cycles of heat and cold often cause serious loss of bolt torque on aluminum flanges.

To study this problem, Armstrong engineers set up simulated service tests with stock automotive transmission housings. These housings all have large aluminum members that are subject to wide variations in temperature, and all require high flange pressures.

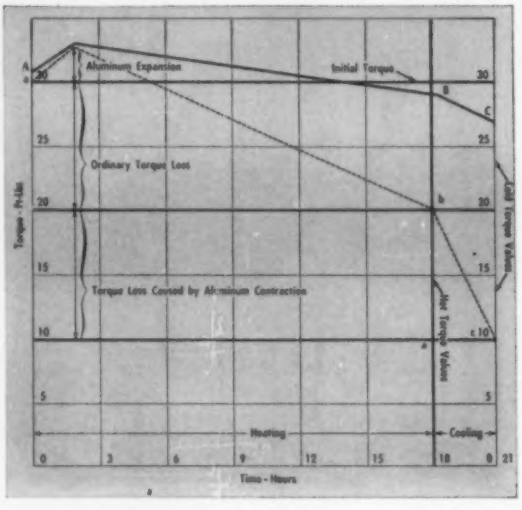
The initial result of the tests indicated—as expected—that the expansion of the aluminum had the effect of substantially increasing the unit load on the gasket. The consequent crushing and extruding of the conventional fiber gaskets led to loss of bolt torque.

The study also turned up other data unique to aluminum flanges. This is the difference between "hot" torque readings—taken while the transmission is at 300° F.; and "cold" readings, taken after the assembly cools. With iron or steel flanges, there is no significant difference between these readings. With aluminum, however, the difference often is 20% or more.

The difference between "hot" and "cold" torque readings is a measure of the ability of a gasket to "follow" the flange as it undergoes dimensional change. Ideally, a gasket should show no difference between hot and cold torque readings. It should resist crushing under high pressures and high temperatures—and it should compensate for the contraction of the flange as it cools.

Because conventional materials fall short of these requirements, Armstrong engineers set out to develop a new type of gasket. Their work resulted in a new beater-saturated asbestos material—Accopac AN-890. This new gasket resists crushing under pressures of 100,000 psi at temperatures up to 350° F., and it has superior torque retention characteristics.

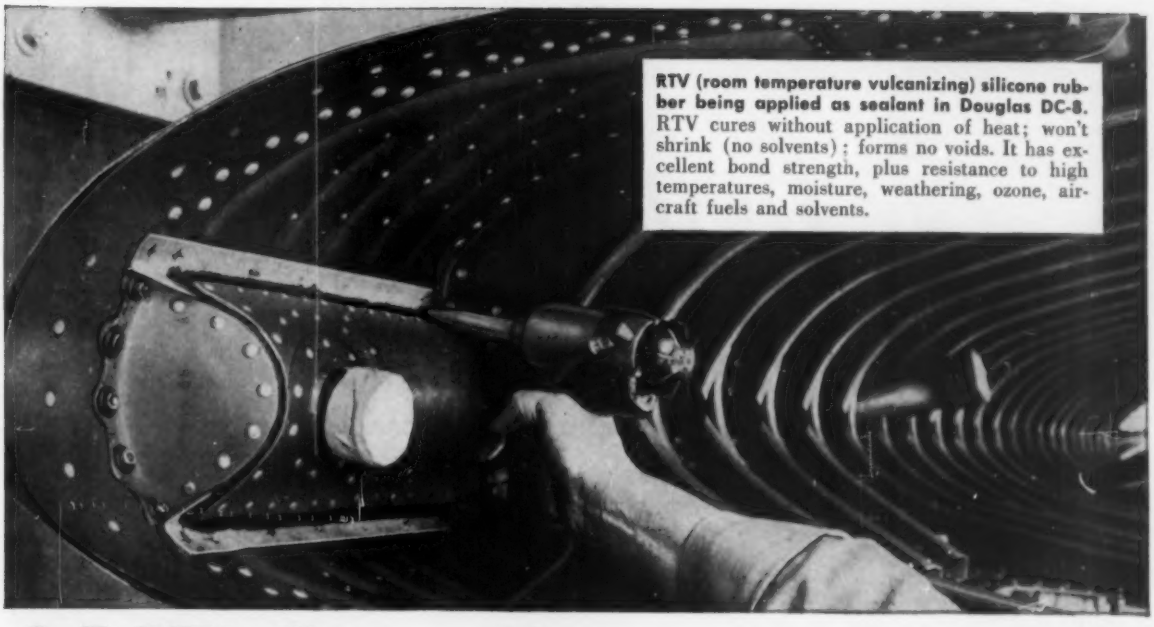
Our research on aluminum flanges may be useful to you. We will be glad to make suggestions if you will send details of your problem to us.



Although high pressure and heat will cause some torque loss with any gasket, it is obviously important to keep such loss at a minimum. Test results on this chart were obtained from transmission housing heated to 300° F., then allowed to cool. The dotted line represents average test results with conventional gaskets. Note difference in torque values (b & c) compared to initial torque (a). The solid line is an average result of tests with Accopac AN-890. Note that hot and cold torque readings (B & C) are very close to initial torque value (A).

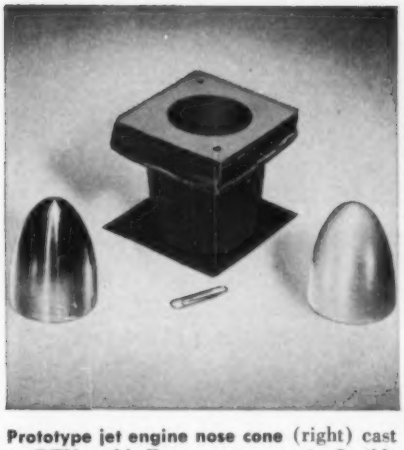
Armstrong GASKET MATERIALS

. . . used wherever performance counts

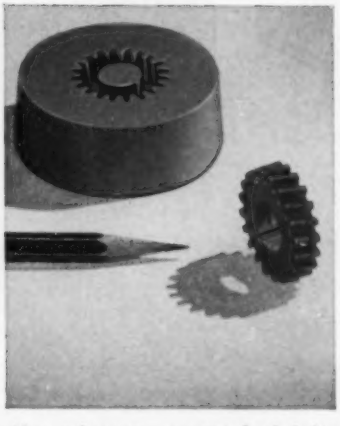


RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



Prototype jet engine nose cone (right) cast in RTV mold. Epoxy parts cast in flexible RTV molds have a bright, glossy surface and reproduce extremely fine detail. No parting agent is required for even the most complex parts. High tensile and tear strength is retained even after prolonged heat aging.



Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

Potting and encapsulating of electrical components, such as this aircraft transformer, are easy with RTV. It can be poured, sprayed, painted or applied by dipping. Temperature resistant from −60°F to +600°F; excellent resistance to high altitude arc-over and corona. Comes in wide viscosity range.

For application data and samples of General Electric RTV silicone rubber, write to General Electric Company, Silicone Products Department, Section A62, Waterford, N. Y.

GENERAL ELECTRIC

Silicone Products Dept., Waterford, N. Y.

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

Bonderite's best for Aluminum, too!

Better paint adhesion, better corrosion control

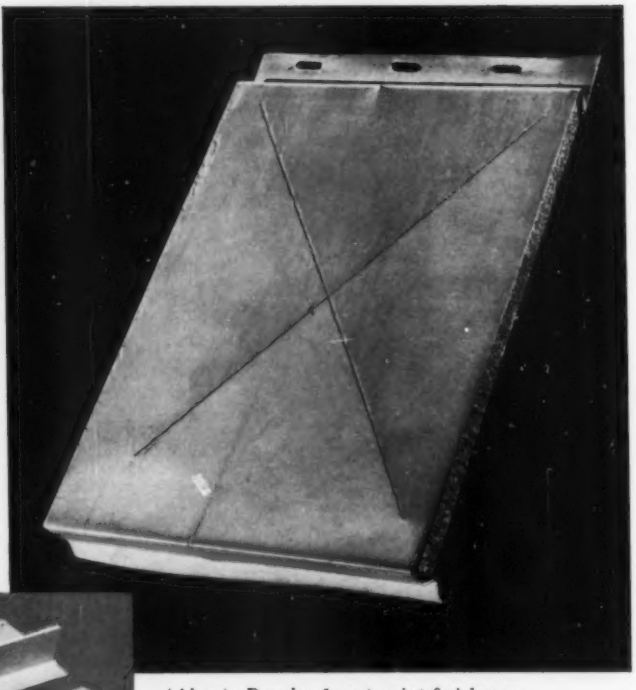
Here's the most famous name in the whole metal treatment field. Bonderite!

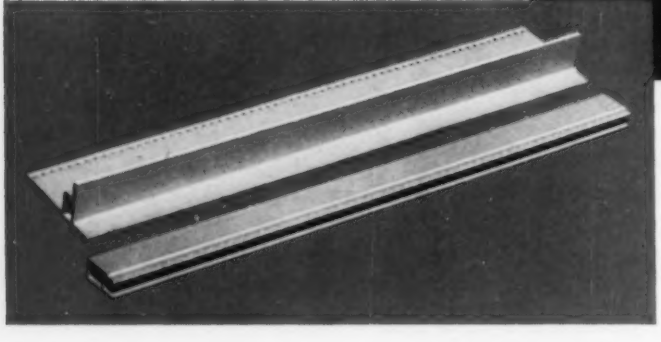
This is the product name that has meant finest finish protection and customer satisfaction to buyers of automobiles, home laundry equipment, refrigerators, metal furniture and other painted metal products for a generation.

This year, over 10 million Bonderite seals will be used on metal products to tell buyers they are getting the plus values of Bonderite protection.

As protection for aluminum, Bonderite's performance is equally spectacular. It controls corrosion, anchors paint.

Sell aluminum siding, awnings, windows, doors and panels that are protected by Bonderite. Sell with complete confidence that the product's good looks will last and last!





(Above): Regular 1-coat paint finish over section of Bonderite-treated aluminum siding. Formed after painting. Tested in salt spray 1500 hours. (Siding by Hastings Aluminum Products, Inc., Hastings, Mich.)

(Left): Aluminum window and screen frame sections Bonderized, painted in the strip, formed after painting. No breaks in finish anywhere! (Frame by The Security Companies, Detroit, Mich.)

Since 1914—leader in the field

Parker Rust Proof Company

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BONDERITE corrosion resistant paint base	BONDERITE and BONDERLUBE aids in cold forming of metals	PARCO COMPOUND rust resistant	PARCO LUBRITE—wear resistant for friction surfaces	TROPICAL—heavy duty maintenance paints since 1883

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

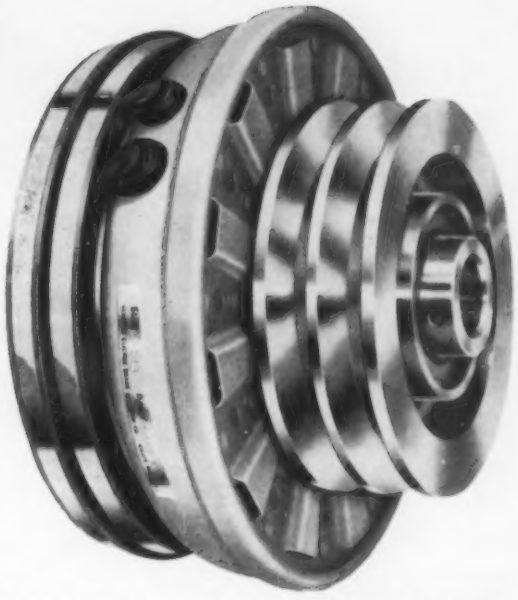
automatic control and easy jogging economical for any machine

Warner's new Electro-Sheave

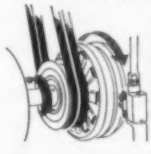
. . . adds all the benefits of electric motion control to any motor-driven machine at a practical price.

Warner's new combination clutch-pulley package saves you money two ways: 1) It comes to you off the shelf, in one, low-cost, precision assembly. You mount it directly to any standard NEMA motor shaft (new or old)—there is no engineering, machining, or alignment to worry about. Just slip it over the motor shaft, tighten a setscrew, mount the brushholder, belt the sheave to the machine and it's ready to go—in minutes. 2) It simplifies control. Any switch actuates the clutch. Simple wiring to the control panel and brushholder reduces assembly costs, eliminates mechanical linkages, levers, solenoids, and other actuating hardware.

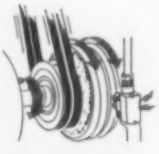
The Electro-Sheave fits right into your design scheme—gives your machines such advantages as faster no-load starting, precise inching and jogging, adjustable torque, automatic control, smaller drive motors, reduced power consumption, and longer motor life. Five sizes (1 to 25 hp) are now available from all Warner distributors. Sheave sizes and styles accommodate most power requirements.

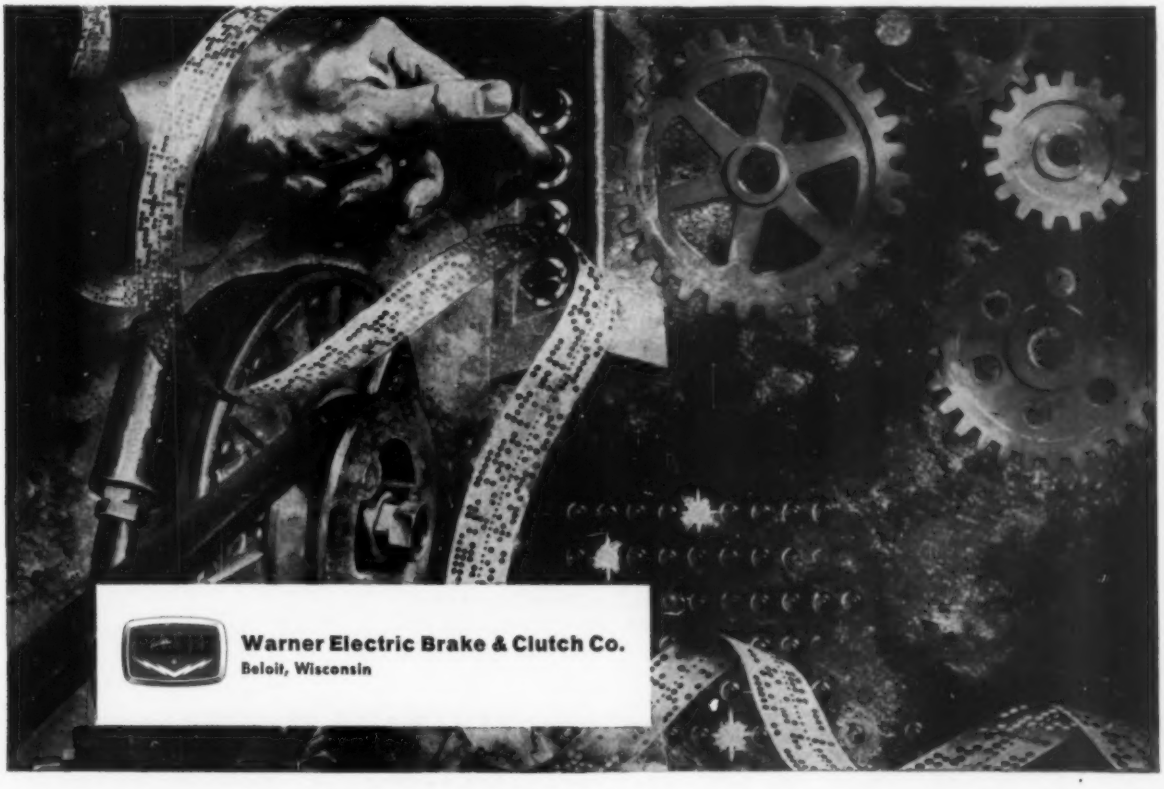


For complete information on installation and operation, including cutaway drawings, description of controls, and selection charts—send for your copy of the new, fully illustrated 10-page booklet, No. P-52.



In operation . . . motor and shaft-mounted magnet run continuously. Sheave and armature are free-running on ball bearings. Energizing the clutch couples the rotating magnet and armature, transmitting motor torque to the drive sheave.



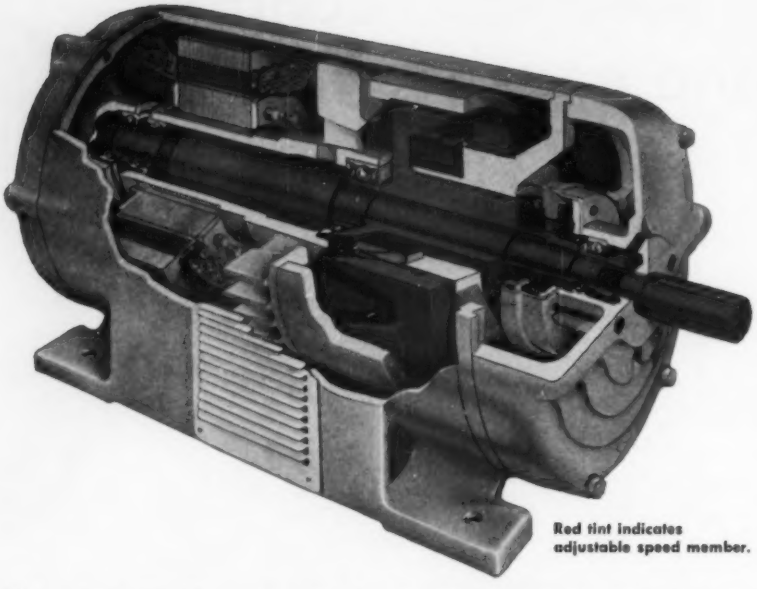


Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

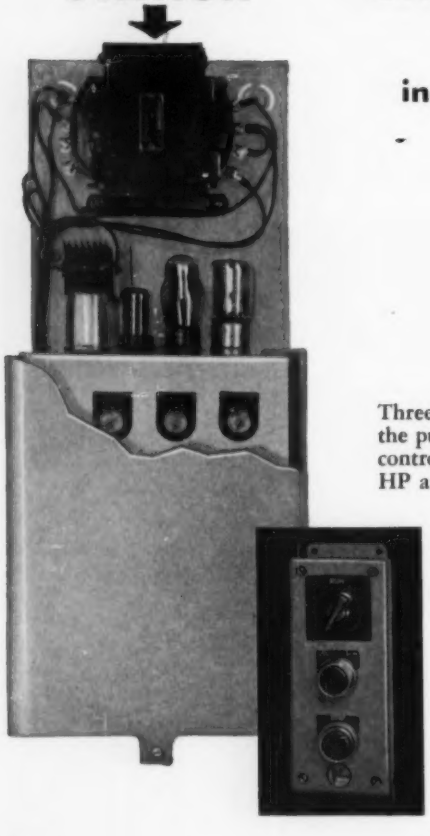
THIS NEW QUILL-TYPE AJUSTO-SPEDE® DRIVE

Plus

THIS NEW K-2 CONTROL and PUSH-BUTTON STATION



Red tint indicates adjustable speed member.



Give You Controlled Adjustable Speed from an AC Power Source

in a Compact, Low Cost 3-Unit Drive Package

by

DYNAMATIC®

PIONEER IN EDDY-CURRENT EQUIPMENT

Three compact components, the Ajusto-Spede Drive, the K-2 Control, and the push-button station make up this complete drive package which provides controlled adjustable speeds for any application from ½ HP through 7½ HP at 1800 RPM.

Remote wall mounting of the control panel conserves space on the driven machine; the push-button station places vital controls at the operator's finger tips.

Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control by the installation of a single resin-encapsulated circuit.

Send for complete information covering design and operation of the new models ACM-903 and 904 Ajusto-Spede Drives. Read how the new K-2 Control provides infinite speed adjustment, on-off clutch control, constant speed control, jogging, threading, cascading, and acceleration control.

Our New Bulletin K-2-159 is Now Available.

EATON®

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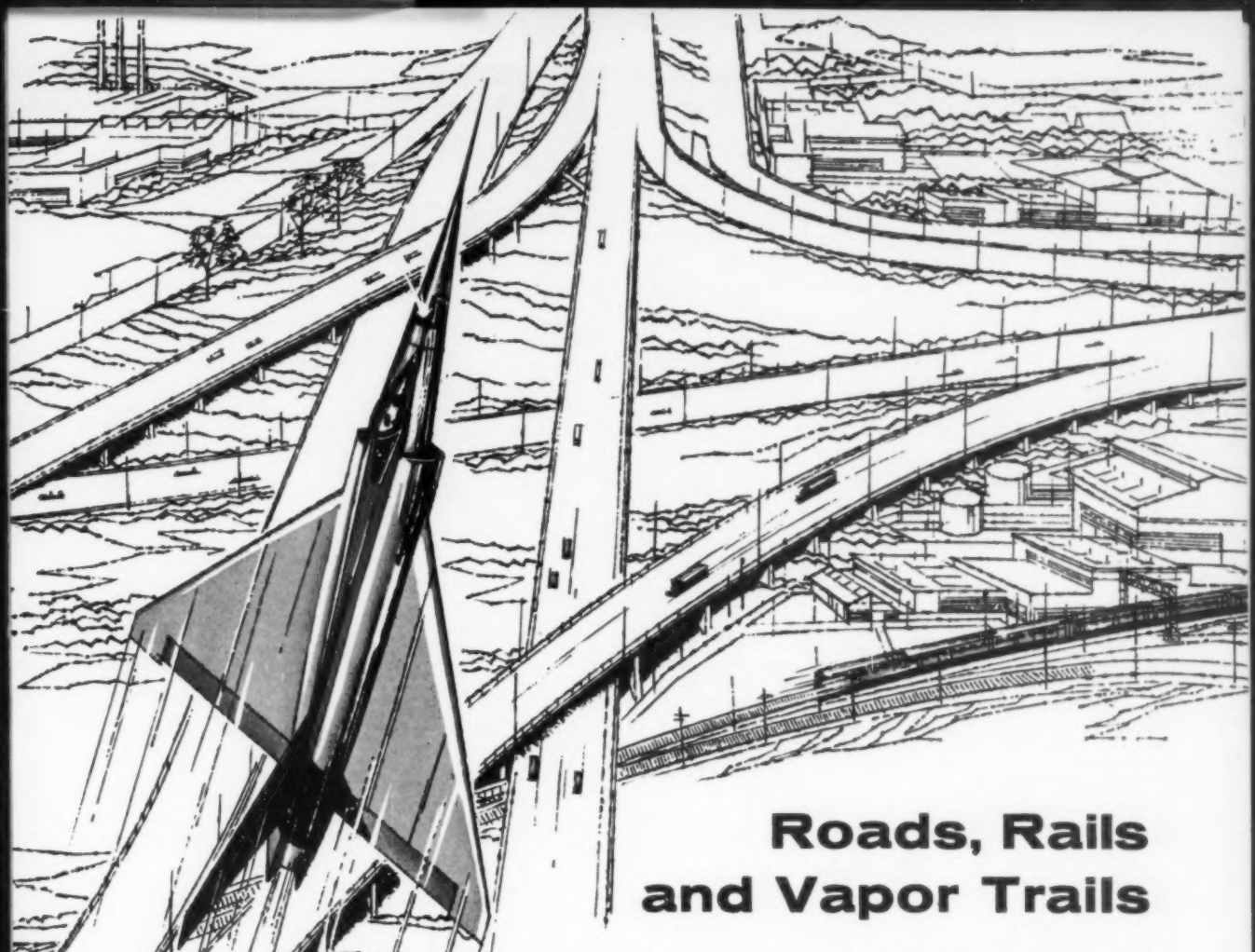

Roads, Rails and Vapor Trails

Whether it hugs the earth or rides the stratosphere's jet streams, **modern** transportation has one **un**common denominator—stainless steel.

America's first **supersonic** bomber — the world's **lightest** full-size, railroad passenger car—the trucking industry's **highest capacity** lightweight trailer—all owe their existence to stainless steel's extraordinary strength-weight ratio and almost indestructible good looks.

Every American auto on the road today uses stainless steel functionally and decoratively to protect painted and treated surfaces, because only stainless steel requires no protective treatment to preserve factory freshness and assure lasting customer satisfaction. **And** its unusual workability means that finished product costs are usually lower than for any other bright metal.

Whether your primary interest is function or form, J&L provides **consistent** quality for uniform production.

J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, **and production economies begin.**

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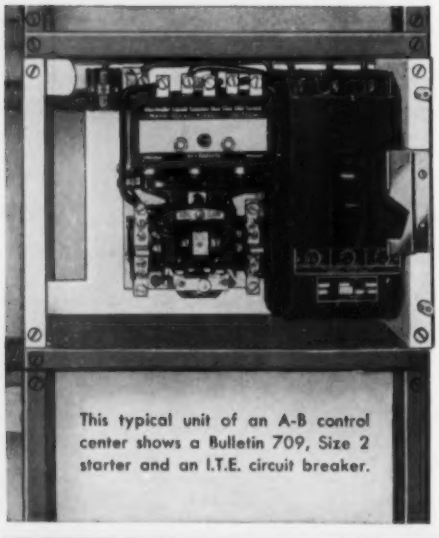
Advanced Design Features in a Control Center . . .

ALLEN-BRADLEY

CONTROL CENTERS

. . . offer tops in
FLEXIBILITY • SAFETY
QUALITY APPEARANCE



This typical unit of an A-B control center shows a Bulletin 709, Size 2 starter and an I.T.E. circuit breaker.

Allen-Bradley control centers are the "label" of a modern plant. They make neat, centralized installations and—where this is practical—do away with individual starter mountings and complicated wiring. The control center may even reduce installation cost—as compared with using individual starters. Here are some of the up-to-date design features which make the A-B control centers so popular.

NEW SPACE SAVING DESIGN—New Bulletin 798 control centers save floor space . . . provide up to 8 units in a 90" high control center unit.

PREMIUM QUALITY FINISH—An exclusive A-B finishing process assures that your control center will retain its attractive appearance over the years. Each piece is *individually* cleaned and phosphated *before* assembly—there are no "bare spots" where corrosion can have a start. Then a rust-resisting primer and a dense finish coat are baked on, providing a fine, tough, and lasting surface.

FLEXIBILITY—A-B control centers are readily adaptable to changes in operating needs—integral plug-in units can be added or modified without internal rewiring. Entire sections are easily added as needed.

SUPERIOR PERFORMANCE—Using the popular A-B solenoid starter—with only ONE moving part—assures millions of trouble free operations. Their double break, silver alloy contacts *never* need servicing.

For "tops" in control centers, you owe it to yourself to investigate Allen-Bradley's Bulletin 798. Write for complete information.

ALLEN-BRADLEY

MEMBER OF NEMA

Allen-Bradley Co., 1329 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL

CIRCLE 139 READER SERVICE CARD

CIRCLE 140 READER SERVICE CARD →

PHOTO BY KARSH OF OTTAWA

"Materials are important to the designer. . . thats why Talon, Inc. works with Sharon"

—THANE E. HAWKINS, chief engineer, Shu-Lok Fastener Division, Talon, Inc.

"To design properly the engineer has to know materials—their advantages and limitations," states Thane E. Hawkins, chief engineer, Shu-Lok Fastener Division of Talon, Inc.

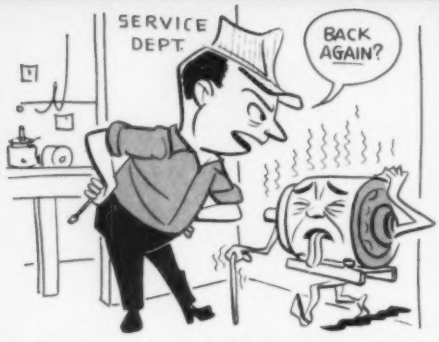
"The Shu-Lok, we knew, would have to absorb extra heavy punishment—yet be as inconspicuous as possible. This meant a small, tough precision product. These factors dictated the use of steel—stainless steel. To get the quality stainless we needed, it was only natural to look to *Sharon Steel Corporation, Sharon, Pa.*"

SHARONSTEEL **SHARON** *Quality* **STEEL**

If you're troubled with these hidden costs, your product needs | BODINE MOTORS

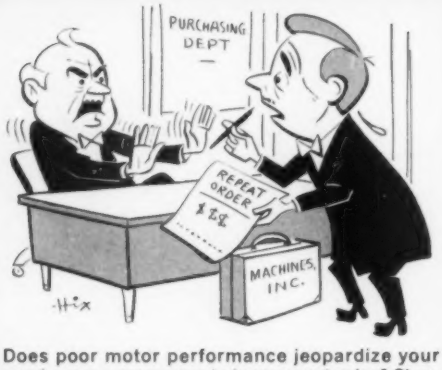
Cartoonist Sid Hix looks at the expenses of buying "second best" motors.

Are too large, hard to install motors slowing down your production line? Bodine motors are compact, light-weight, powerful for their size and available with a variety of mechanical adaptations.

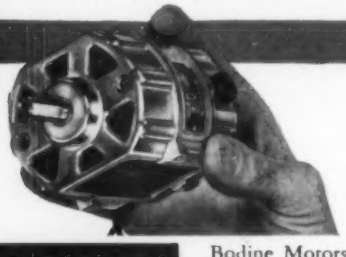


Are frequent motor breakdowns nullifying your product's other competitive advantages? Highest quality workmanship and materials make long life and service free operation inherent characteristics of all Bodine motors.

Are on-the-line motor rejections adding to your production costs? Close supervision throughout all manufacturing processes, plus individual inspection and testing of completed Bodine motors minimize rejections.



Does poor motor performance jeopardize your good name—cause you to lose repeat sales? Close tolerance machining plus quality materials plus close inspection and testing of each Bodine motor assures consistent performance.



3500 standard motors... 295 stock motors

If you're planning new or improved products, talk to a Bodine motor-application engineer. Probably one of Bodine's 3500 standard motors is perfectly suited to your product. And Bodine carries in stock 295 different standard types and sizes of motors ...ready for immediate shipment. **(Ask for Bulletin S-1.)** Bodine Electric Company, 2510 West Bradley Place, Chicago 18, Illinois.

BODINE
fractional horsepower
MOTORS

Bodine Motors are used in: office machines, instruments, communication equipment, sound recorders, automatic scales, respirators, voltage regulators, X-ray timers, traffic signal timers, stirrers, sanders, letter openers, envelope sealers . . . and many, many other types of equipment.

...the power behind the leading products

PERSPECTIVES

in design and development . . .

So you want to be a manager

A full-scale debate on research management has been raging in some of the "quality" business publications recently. One group—the scientists themselves—says R & D personnel are different. They should be given the university atmosphere, the best equipment available and freedom to choose their own projects. They should be exempt from most of the rules and regulations obeyed by other company employes and completely free from concern about the economic aspects of the business.

The opposition—old-line professional administrators—say the major cause of project failure is that R & D is permitted to select its own projects. Instead, "Projects should be chosen from a total, integrated company point of view." They insist that "R & D personnel are motivated by the same things as other people and respond to the same constructive management approaches long utilized in other areas of the firm."

The description we like best was given by Merritt A. Williamson, dean, College of Engineering and Architecture, Pennsylvania State University. Says Dean Williamson:

"We are told that the good manager must be personally efficient. He must always have a tidy desk that's cleared for action. He must delegate everything to others so that he is prepared for the truly important problem. He must not be interrupted for anything trivial as determined by outer office staff. He must know where every file is located. He must have a well-trained secretary who will produce things for him at a moment's notice and keep unimportant visitors out. He must give his decisions without hesitation. He must be dynamic and decisive.

"A manager of this sort is terrific . . . for managing a group of salesmen, or supervising the filling of orders in a mail-order house, or running some governmental agency where the policies are clear-cut and definite. But I question his success in R & D.

"The R & D manager should be quite the opposite. I think he may well be quite inefficient. He may run a pretty sloppy office. His desk may be piled high with all sorts of diverse material reflecting a divergence of interest. He'll have a constant struggle with delegation of authority. He knows he should do it, but he's too much of a perfectionist for this to be easy. He'll want to be interrupted at times, particularly for technical problems. These are most apt to be the ones which hold a real fascination for him. He may not always be prompt in sending documents to the outer office for filing. He will not make a big production about summoning people to his office. Rather, he will take the highly inefficient action of finding them wherever they may be. He'll then proceed to extend his conversation beyond the item at hand. By this inefficient action he creates the best possible aura of understanding which is the key to greatest productivity when one is dealing with creative persons.

"As to being dynamic, decisive, and clearcut, this is one of the worst traits for an R & D manager. I'll grant that he should feign this attitude when his supervision has to be impressed, but I think he should avoid it as far as possible where his subordinates are concerned. The decisions which the good technical manager must make are not issues that can be resolved. They invariably require careful thought and considerable weighing of technical evidence. A quick decision would be distrusted . . ."

Sounds thoroughly human, doesn't he?

CASE HISTORIES

New Departure super precision angular contact bearings add new sales appeal to high frequency grinding spindles.

Photo: Courtesy Bryant Chucking Grinder Co., Springfield, Vermont

N/D Ball Bearings Cut Costs $180.00 On 100,000 RPM Grinding Spindle!

CUSTOMER PROBLEM:

Machine tool maker experienced excessive assembly time with integral shaft type ball bearings in the production of 100,000-rpm grinding spindles for precision grinders. The ball bearing, with ground shaft serving as inner race, plus special balls, separator and outer race, required careful parts matching and assembly. Also, shaft and bearing replacement costs, if required, were high.

SOLUTION:

N/D Sales Engineer, in cooperation with the manufacturer, recommended using New Departure production ball bearings fitted directly to the shaft. These super precision, ultra high speed ball bearings eliminated the need for ball track grinding and delicate eccentricity matching at assembly. Using N/D ball bearings and engineering assistance, the manufacturer reduced parts and assembly costs $180 per unit. What's more, in the rare case of spindle damage, shaft assembly replacement costs have now been reduced $175 (over earlier models) . . . shaft assembly or bearings can be replaced separately, thanks to New Departure.

If you have new machine tool designs on the board, or are experiencing questionable costs in production, why not call on New Departure? There's probably a high precision N/D production ball bearing that can save you time or money! For more information, write Department P-6.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

The Tortoise beat the hare only in a fable

"Haste makes waste" is perhaps the most oversold proverb of modern man. The impression has been created—and is strongly supported—that a job done quickly is a job done poorly, that careful, step-by-step progress is the only sound advance. This despite the masterpieces of art, music, literature and even engineering that have been done at high speed, despite the many successes of "mad men" who plunge ahead in the face of obviously insurmountable obstacles, despite the opportunities missed by plodders.

Some years ago, Harvard University made an extensive study on the subject. The findings were disheartening to the proponents of the "slow-but-sure" school, but the myth of advantage in deliberateness still persists. Harvard found that the faster worker made fewer errors in every test that was run—that the faster worker was also the better, surer worker—that in fact the hare beat the tortoise.

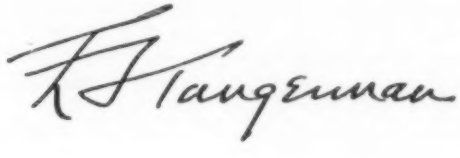
These observations are suggested by the steady shift of American business to larger, more-cautious organizations. For with size comes financial stability, resources—and infinite caution that amounts almost to reactionism. The corporation has a tendency to stall on change, because its executives are fearful of rushing into error. The problem is complicated by the difficulties of modifying our inflexible mass-production setups, and the cost in engineering and tooling time.

Actually, this creates the opportunity for the small business that can be daring, can be light on its feet. It also creates opportunities for the consultant and the inventor who care to suggest radical changes—if they can get their ideas to someone who is willing to take a chance.

Too often, the sponsorship such an "idea man" gets is not at the engineering level, but among non-engineering top executives. In a number of cases, inventors have told me of the large corporation whose engineers conservatively reject his "different" idea, only to have the corporation pay through the nose later to buy up the little company that developed it. Or, again, there are the cases of the newcomer to a particular field who plunges in without the necessary background of knowledge and experience—and takes the market away from the solidly entrenched oldtimer. You can find your own examples in such fields as high-production machine tools, missiles, jet engines, instruments, diesel engines, locomotives, buses.

Audacity plus confidence pays off, whether it be "Pike's Peak or Bust", "Go for Broke", or "Tomorrow the Moon." A recent quotation says it more clearly than pages of exposition. Here it is:

"Strange how prudent men cautiously walk into oblivion, while audacious men indiscreetly rush into immortality."



NYLON'S **TOUGH NEW RIVAL**

ITS PARTS ✓look like nylon ✓perform as well ✓cost half as much

M S THOMPSON, *senior group leader, Naugatuck Chemical Div, U S Rubber Co*

A new medium-impact gum plastic that promises to give nylon some sharp competition has stepped into the ABS (Acrylonitrile-Butadiene-Styrene) family.

Designated Kralastic-MM, the new rubber-plastic blend was specifically tailored to meet nylon's deficiencies—at about one-half nylon's price per pound. The "thrifty man's nylon" is a molding material also designed to rival other recent tough, rigid thermoplastics like Delrin acetal resin and the polypropylenes.

Nylon's reputation for rigidity, high strength, and resistance to heat, wear, and staining is well established. With this versatility go such problems, however, as high moisture pickup, need for special attention to the molding operation, and—most important to the designer—relatively high cost. The new ABS polymer meets these drawbacks:

- Cost is about 40% that of nylon molding powder. Additional savings can come in the molding operations and elimination of certain post-molding treatments.
- Moisture content at equilibrium with average relative humidity conditions is 0.35% compared with 2.5% for nylon.
- Rigidity and creep resistance are exceptional for thermoplastics. Modulus is twice that of nylon, while creep is less than one-quarter.
- Variants are available, as with nylon, to offer a broad range of properties.
- Abrasion- and mar-resistance, while not the equivalent of nylon, can be rated "good" for this group of plastics.

Though nylon-like in its balance of properties, Kralastic-MM does not behave identically. In some cases, it is distinctly superior; in others, not as good. These differences show at a glance in the accompanying curves and tabular data.

The cost comparisons go further than raw material prices. Experience has shown that nylon's molds must be built precisely because of its great "flashing" tendency. Often, because of the experience and attention required, extra overhead charges are involved. This may come at the prototype stage when high and uneven mold shrinkage calls for reworking a cavity to get proper dimensions and tolerances. Special post-molding conditioning, such as soaking for dimensional stability or toughness, can cost extra, too. The new gum plastic, on the other hand, has performed normally during molding and should reduce such problems.

Where Properties Differ

The new Kralastic's appearance, both in basic color and gloss, is very similar to nylon. Opacity is slightly greater. This may be important where light transmission is vital, but has little effect in most colors. A special

formula has the same opacity. Painting and printing are readily accomplished with standard techniques—normally impractical with nylon.

Dimensional tolerances on any molded plastic part are influenced by mold shrinkage, moisture absorption, and sensitivity to temperature—their relative dominance depends on the plastic. Though nylon shrinks more in the mold than does the new polymer, this can be compensated for. With a thermal expansion coefficient about 60% that for nylon, Kralastic-MM has improved dimensional stability under fluctuating temperatures. Low moisture absorption is the major advantage here, however. This difference—roughly 5 to 1—can be compensated for in the case of nylon. But in the initial part design, when moisture content varies in use, the plastic with lower sensitivity will provide more constant dimensions.

Strength can also be influenced by moisture absorption. For example, the high tensile strength of nylon drops almost 30% when normal equilibrium content is attained and modulus drops to less than one-half. The new blend is not so affected and retains its modulus better than most impact plastics. While the table lists the results of standard short-time tests, the real significance of this feature is apparent from the long-time creep curves on the next page.

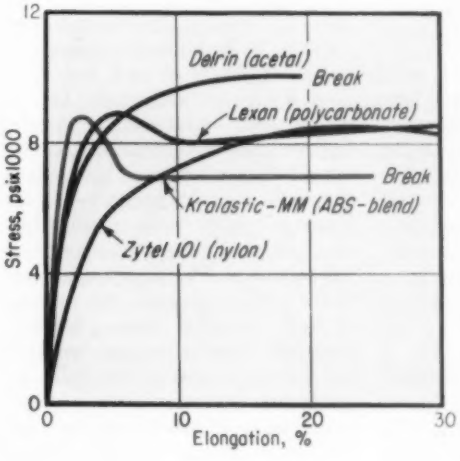
These curves highlight room-temperature creep resistance as a key performance feature of the new polymer. Data now being assembled show high-temperature creep performance is good too: at 160 F and 2200 psi, it creeps somewhat less than Delrin acetal resin. The last set of creep curves shown will set design limits for long-time loading. For example, taking a limiting deformation of 5%, (a fairly common design factor), over a 10-yr continuous loading life the design stress should be kept between 2000 and 3000 psi. These design curves are continued to 10% elongation to cover most projected uses. This limit is less than half the total elongation to creep failure.

Impact resistance of the new gum plastic compares closely with that for nylon. However, Izod values alone seldom tell the whole toughness story. When stiffness of the materials is considered, their behavior to shock

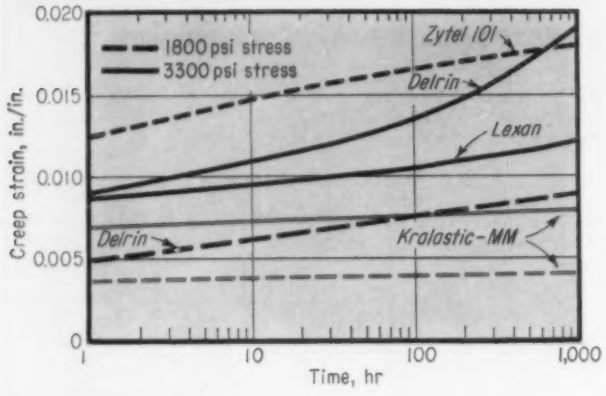
THREE PLASTICS—A COMPARISON

(Columns 1, 2 and 4 are as-molded; column 3 shows influence of moisture pickup on nylon. For average air exposure, 73 F, use Cols 1, 3 and 4. Blank entries in Col 3 denote no information available on change due to moisture pickup.)

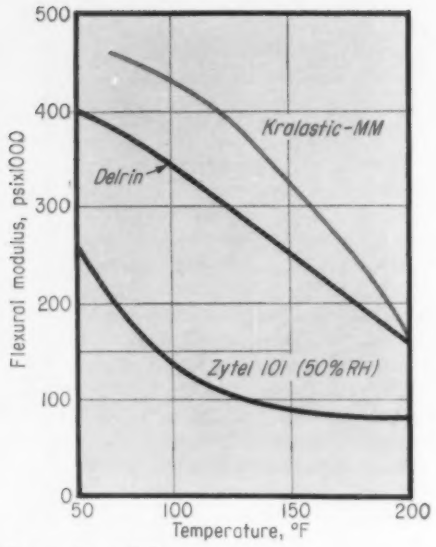
	Costs and Properties	Kralastic—MM (ABS-blend)	Zytel 101 (nylon 6/6)		Delrin (acetal)
	Moisture content, % . . .	1	2	3	4
		0.35	0.5	2.5	0.2
GENERAL	Specific gravity	1.07	1.14		1.43
	Cost, cents/lb	2.0	4.9		4.9
	dollars/lb-volume	0.54	1.35		1.35
	Molding cost				
	tooling (includes proto. work)	Normal	High		——
	production rate	Normal	Normal		——
	Ease of molding	Good	Fair		——
	Mold shrinkage, mil/in.	4	15		20
	Moisture absorption (24 hr), %	0.3	1.5		0.12
	Abrasion resistance (Tabor CS17 wheel, mg/1000 cycles	14-15	6-8		20
MECHANICAL	Tensile strength, psi × 10^3	8.8	11.8	8.5	10
	Flexure modulus, psi × 10^3	450	410	175	410
	Elongation, %	20	60	300	15
	Flexural strength, psi × 10^3	13.5	13.8	——	14.1
	Impact strength (notched Izod), ft-lb/in.	1.5	0.9	2.0	1.4
	Rockwell hardness, R scale	118	118	108	120
	M scale	66	79	59	94
THERMAL	Heat-distortion temp.				
	(264 psi), °F	200	150		212
	(66 psi), °F	217	360		338
	Heat resistance (continuous), °F	190	250		185
	Expansion coeff., in./in./°F × 10^{-5}	3.2	5.5		4.5
	Conductivity, btu/hr/sq ft/°F per in.	1.80	1.68		1.60
	Flammability	Slow-burning	Self-exting.		Slow-burning
ELECTRICAL	Dielectric strength, volt/mil	386	385		500
	Volume resistivity, ohm/cm × 10^{14}	270	0.5		6
	Dielectric constant	3.1	3.9		3.7



Stress-strain curves . . . at room temperature compare new ABS polymer with other tough, rigid thermoplastics. It closely resembles GE's Lexan in mechanical behavior; its tensile modulus is highest of the four.



Creep resistance . . .
is an outstanding characteristic of the plastic. Room-temperature creep comparisons show its negligible plastic flow at two stress levels. Performance at higher temperatures is good too.



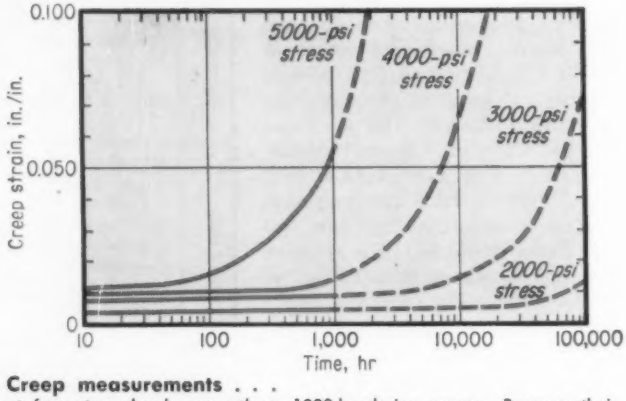
Flexural modulus . . .
of Kralastic-MM remains high up to the max recommended continuous-use temperature of 185 F. At 200 F, the modulus is roughly twice that of nylon.

loading differs. Kralastic-MM reacts by resisting it with only slight deformation; nylon, by offering less resistance, with accompanying deformation. This behavior comparison also applies to slowly applied stress of unusual magnitude.

Heat-distortion temperature for the two plastics shows a basic behavior difference. At low stresses, highly crystallized plastics like nylon and Delrin acetal resin take much higher temperatures with little deformation. As stress rises, however, the allowable temperature drops rapidly: Here the ABS plastics—with a much flatter temperature-stress characteristic—cross over and perform best. Design, then, must choose materials for the kind of heat resistance desired. With Kralastic-MM, for example, a top continuous-use temperature would be about 185 F, but stresses can be higher at this temperature than for nylon.

Resistance to marring and wear, outstanding in nylon, comes from high surface hardness and low coefficient of surface friction. The new polymer has comparable hardness but is less slippery. Abrasion resistance is therefore somewhat lower. While Tabor abrasion values can serve as a rough guide, wear performance of plastics has been found from experience to depend heavily on simulated service tests.

Chemical resistance of plastics, if stated briefly, should always be verified for the individual application. Nylon has an excellent reputation for chemical resistance (except to certain acids) because it resists most common organic solvents. So does the new gum plastic—and it resists most acids and alkalis even at high concentrations. It is attacked when aromatic and chlorinated hydrocarbons are the major constituents; if these are in minor proportions, the plastic may give good service. Aliphatic hydrocarbons like gasoline have no effect, nor do many common staining substances like lipstick and nicotine. On the other hand, the existence of some common solvents for Kralastic-MM allows cementing, painting, and printing upon molded parts.



Creep measurements . . .
at four stress levels gave these 1000-hr design curves. Because their shapes, after study, proved to be all the same, the higher-stress curves were used to extrapolate less-complete, lower-stress curves to 100,000 hr.

Although the new polymer is just out of the development stage and production applications are yet to come, many industrial parts have been experimentally molded and are now being evaluated. These include gears, bearings, and cams; fan blades and pump rotors; housing and panels for appliances, business machines, cameras and small motors.

For REPRINT of above article, check E86 on a Reader Service card in this issue.

EDITOR'S NOTE: Other articles of interest in selecting plastics for structural applications include the following: "Three New Tough, Rigid Thermoplastics—A Comparison," Sept. 29 '58, p. 36; "New Nylon from France," Dec. 23 '57, p 76; and "How to Choose Tough, Rigid Thermoplastics," Nov '56, p 167.

More on PHOTOSTRESS

STRAIN-MEASURING METHODS such as photoelastic models, strain gages and brittle coatings have long been applied in scientific measurements, but have only recently been finding wider application in product design. PhotoStress (*PE*—Mar 2, p 43) obviously widens the field of use of strain measurement in design. But the solid background of experience in scientific applications should not be ignored.

The following comment given to PRODUCT ENGINEERING by Mr. Stein, author of a series of earlier articles on strain-gage technique (July '56, p 144) reflects this scientific viewpoint. He is answered, with emphasis on the designer's interest, by Dr. Zandman, developer of PhotoStress and author of the article describing the technique. For another article by Dr. Zandman—on how to get PhotoStress values direct from the polariscope—see our next Design issue.

By Peter Stein, Editor, Strain Gage Readings, Phoenix, Ariz:

Both the article that you ran on PhotoStress and the edtiorial policy by which PRODUCT ENGINEERING supports and popularizes new developments in the stress analysis field, are excellent and enjoyable. The case history of PhotoStress is reminiscent of the brittle-material method. In the 1930s, investigators were building models out of plastic materials for photoelastic studies—at the same time they used models built of brittle materials such as plaster of Paris, to study failure criteria. The technique of coating actual working parts with brittle coatings (instead of building models out of the stuff) was first developed in Germany and received its final impetus from Greer Ellis' creation of Stresscoat which is the most popular form of brittle coating used for stress analysis of actual parts today. It took longer to perfect a method for producing photoelastic coatings, but otherwise the developments are quite parallel.

It is interesting to note that when Stresscoat was as old as PhotoStress is today, PRODUCT ENGINEERING carried an article on it in much the same vein as the two PhotoStress articles in recent years. It is quite probable that early articles like that helped spread the gospel of Stresscoat and of the desirability of experimental analysis of stresses in general.

In spite of the desirability of calling new methods to the attention of the public, PRODUCT ENGINEERING surely does not intend to slight the present methods. The following modifications to your table of comparison between PhotoStress and strain gage torquemeters may be in order:

1. Temperature limits on strain gage torquemeters greatly exceed 250 F. Static torques as high as 550 F and dynamic torques up to over 1200 F have been measured successfully.
2. Torquemeters are being used today at speeds to 90,000 rpm, not the 3000 mentioned in the table.
3. Response time is in fractions of a millisecond as compared to the 1.5-sec full-scale rating for the PhotoStress method.
4. Slip rings are neither necessary in these days of miniaturized telemetering transistorized systems, nor are they the impossible horror they are often pictured to be.
5. Any normal shaft surface can be prepared for strain gage attachment without line-of-sight access for optical paths.

By Dr F. Zandman, Director of Basic Research, Tatnall Measuring Systems Co, Subsidiary of The Budd Co:

Mr. Stein's modifications to the comparative performance of torquemeters are unquestionably correct, if the comparisons were between PhotoStress and strain gage torquemeters, as he states. However, the table was added to the text to give the reader a comparison between torquemeters commercially available from stock. Hence the heading "Typical Strain Gage Torquemeter." Maximum performances of these two methods of torque measurements were not discussed in the comparison table.

Therefore I would like to answer Mr. Stein's modifications to the table point by point.

1. Temperature limitations were taken directly from a Baldwin-Lima-Hamilton catalog on SR-4 torquemeters. PhotoStress readings have also been taken far in excess of the temperature of 250 F which we mention in the tables as maximum PhotoStress temperatures.

2. We should have said that speed limitation ranges from 5000 to 12000 rpm for small-dia shafts and 3000 to 7000 for shafts above 2.5-in. However, the comparison between speed limitations should more correctly have been made on the basis of surface speed rather than rpm. As the shaft diameter increases, the maximum rpm at which a typical strain gage torquemeter installation can be used decreases. PhotoStress is not subject to this limitation up to the point where centrifugal force destroys the bond; this is why the minimum speed in rpm was given as "almost no limit."

3. The 1½-sec response time given for the PhotoStress torquemeter is the time required for the servo system to move full scale. This could be compared to the instrument pickup systems available from Baldwin, which vary from manually balanced to 8-sec full-scale response. The PhotoStress torquemeter is servoed to provide null balance for improved performance over long periods of time and is of course slower than non-servoed systems. Without the servo, response of 30,000 cps and above is possible, which makes PhotoStress comparable to any strain gage system. This was explained perhaps too briefly in the text.

4. The telemetering system mentioned by Mr. Stein is not a standard unit, to the best of my knowledge. To use it, a complicated and relatively heavy system must be attached to the rotating shaft, which must then be balanced. Nothing is required on the shaft measured with the PhotoStress torquemeter except a layer of PhotoStress plastic.

5. For strain gage measurement, special small-dia shafts are usually inserted to obtain the high surface strains of 1000 to 1500 microin/in. required for maximum accuracy. The PhotoStress torquemeter can obtain full-scale deflection for a uniaxial surface strain of 400 microin/in. with plastic 0.1 in. thick.

NEW EQUATIONS *locate* DWELL POSITION of 3-GEAR DRIVES

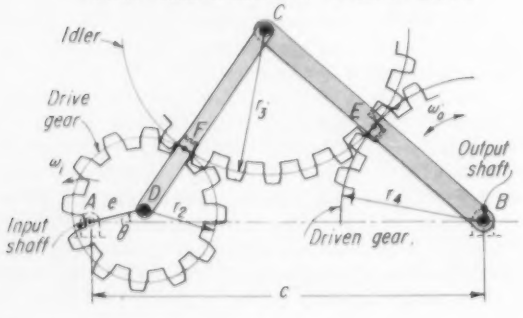
These drives can produce three different motion patterns—depending on how far the output gear is located from the input gear. Author develops equations which—for the first time—pinpoint this all-important dimension.

DR J HIRSCHHORN,
Senior lecturer in Mechanical Engineering
University of New South Wales, Australia

There has been a marked surge of interest recently in the three-gear drive as an intermittent mechanism. Although it is better known for its cyclic characteristics, proper design can give it a smooth momentary pause that is ideal for a quick automatic-transfer or fabrication operation. In contrast with other intermittent-motion mechanisms, the three-gear drive can pick up a load without slightest shock because both velocity and acceleration of the output gear are zero when it is in the dwell position.

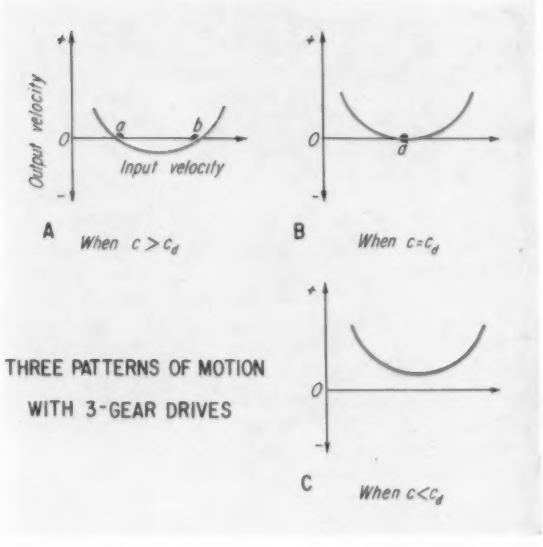
Success in designing such a drive depends on finding correct center-to-center distance between input and output shafts in order to get the desired pause. Initial investigation of the kinematic properties of the three-gear drive has already been performed (see Editor's Note). But the equations developed here provide, for the first time, a direct solution of this "critical" center distance.

BASIC COMPONENTS OF 3-GEAR DRIVE



THREE PATTERNS OF MOTION

The drive is built around a gear mounted eccentrically on the input shaft, plus an idler gear and an output gear. Two links keep the idler in mesh with the output and input gears, but the gears are free to turn with respect to the links.



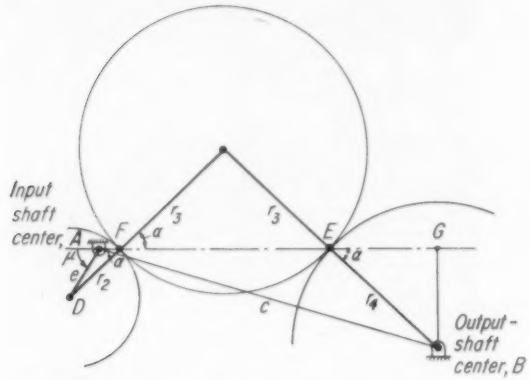
The above comparison of motion patterns shows that when the distance c between input and output shafts is considered adjustable, three patterns of motion are available:

- If c is made larger than a critical value, c_d, the output gear stops for an instant, reverses for a finite period, stops again, and then resumes its original sense of rotation, while the driving gear is completing one revolution at constant speed.
- If c is made equal to c_d, the output gear dwells for an instant, and then continues to rotate in its original sense. Although, theoretically, it pauses only an instant, in and actual mechanism this may last about 45° of the cycle—and is the motion pattern which is usually required.
- If c is made smaller than c_d, the output gear slows down and then accelerates, but does not actually stop.

The output gear comes to rest—positions a, b in (A) and d in (B)—when the instantaneous center of its rotation relative to the driver coincides with the input

shaft center. This is the case when points A, F and E are in line, as shown in the dwell-position diagram below. This diagram shows one of the two dwell conditions that occur when c is larger than c_d. As c is made smaller the

IN DWELL POSITION



two dwell positions occur closer together; therefore, the critical value c_d can be defined as being the smallest center distance which, for a given mechanism, allows points A, F and E to be in line.

THE CENTER-DISTANCE EQUATION

The center distance c can be expressed in terms of trigonometric quantities:

$$c^2 = (AF + FE + EG)^2 + (GB)^2 \tag{1}$$

with

$$AF = r_2 \cos \gamma - e \cos \mu, \tag{2}$$

$$FE = 2r_3 \cos \gamma, \tag{3}$$

$$EG = r_4 \cos \gamma, \tag{4}$$

$$GB = r_4 \sin \gamma, \tag{5}$$

Eq (1) becomes:

$$c^2 = [(r_2 + 2r_3 + r_4) \cos \gamma - e \cos \mu]^2 + r_4^2 \sin^2 \gamma \tag{6}$$

but,

$$e \sin \mu = r_2 \sin \gamma \tag{7}$$

hence,

$$e \cos \mu = \sqrt{r_2^2 \cos^2 \gamma - (r_2^2 - e^2)} \tag{8}$$

Substituting Eq (8) into Eq (6) gives:

$$c^2 = [(r_2 + 2r_3 + r_4) \cos \gamma - \sqrt{r_2^2 \cos^2 \gamma - (r_2^2 - e^2)}]^2 + r_4^2 \sin^2 \gamma \tag{9}$$

To obtain $c_d = c_{min}$, Eq (9) is differentiated with respect to γ, and equated to zero. After some simple but tedious algebraic operations, the following quadratic equation can be obtained involving the angle for the dwell position γ_d:

$$K \cos^4 \gamma_d - L \cos^2 \gamma_d - M = 0 \tag{10}$$

where

$$K = [(r_4^2 - r_2^2)^2 - 2(r_4^2 + r_2^2)(r_2 + 2r_3 + r_4)^2 + (r_2 + 2r_3 + r_4)^4]r_2^2 \tag{11}$$

$$L = [(r_4^2 - r_2^2)^2 - 2(r_4^2 + r_2^2)(r_2 + 2r_3 + r_4)^2 + (r_2 + 2r_3 + r_4)^4](r_2^2 - e^2) \tag{12}$$

$$M = (r_2 + 2r_3 + r_4)^2(r_2^2 - e^2)^2 \tag{13}$$

Knowing γ_d, all other quantities, in particular c_d, can be determined.

SAMPLE PROBLEM

Determine the dwell center distance for the three-gear drive with dimensions $r_2 = 1$ in. $e = 0.8$ in., $r_3 = 2$ in., $r_4 = 2$ in.

Substituting these values into Eq (10) gives:

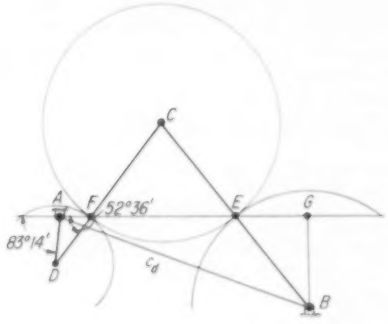
$$1920(\cos^4 \gamma_d) - 691(\cos^2 \gamma_d) - 6.35 = 0$$

which gives

$$\cos^2 \gamma_d = \frac{1417}{3840} \quad \text{and} \quad \gamma_d = 52°36'$$

from Eq (7)	$\mu_d = 83°14'$
from Eq (2)	$AF = 0.51$ in.
from Eq (3)	$FE = 2.43$ in.
from Eq (4)	$EG = 1.21$ in.
from Eq (5)	$GB = 1.59$ in.
from Eq (1)	$c_d = 4.45$ in.

CONSTRUCTION DETAILS FOR SAMPLE PROBLEM



Therefore the distance between input and output shafts should be 4.45 in. The sketch above shows such a mechanism in its dwell position.

REPRINT of this article can be obtained for your reference file by checking E85 on one of the Reader Service cards bound in this issue. For further reprints available see 'Current Reprints" listing in this issue on page 151.

EDITOR'S NOTE: First mention of this mechanism was by S. Rappaport, now with Ford Instrument Co. Mr. Rappaport, in the Jan '50 issue of *Product Engineering* ("Kinematics of the Three-gear Drive," p 120), discussed the basic concepts and showed how to obtain the velocity and acceleration characteristics by graphical means.

How to obtain the critical center distance by graphical construction was shown by J. S. Beggs in his book *Mechanism* (p 50), McGraw-Hill Book Co., 1955.

Incidentally, Mr Rappaport has recently developed a unique but simple way to get reduction ratios as high as 1:5000 from a simple planetary gear system using only four gears. Think it can't be done?—we didn't believe it either until we saw the drive in operation. Details in our June 22 issue.

Static Electricity Prints Photos

The continuous process gives dry prints on plastic-coated paper at a rate of 20 feet per min. Xerographic method needs no liquid or chemical developers—a sensitized drum transfers image from the negative.

Working directly from negative film, the printer produces a 9-by-9-in. print every 2¼ sec. Standard resolution is 750 lines per in. and up to 1500 lines per in. have been achieved. Primary purpose of machine is to reduce time required to prepare useable prints from aerial negatives. Process is extremely flexible; positive prints can be made from positive film; size of the prints can be enlarged or reduced by adding a projection optical system. Unit is contained in a cabinet 6 by 6 by 3 ft, weighs 3200 lb and operates on 220-v 60-cycle current. Produced by Haloid Xerox Inc, Rochester, NY, under sponsorship of the US Air Force and Signal Corps.

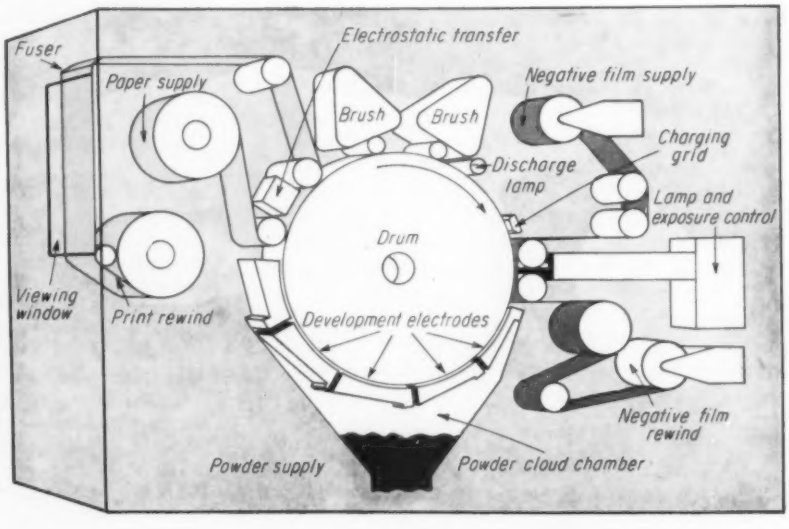
Control panel . . . with print-inspection window allows operator to check prints as they are produced. Xerographic prints are finished 22 sec after exposure of the negatives and are wound on takeup roll before being cut into individual prints. Contrast and exposure may be modified by varying the charge applied to the photosensitive drum. Controls are calibrated to correspond with the various grades of conventional photographic paper.

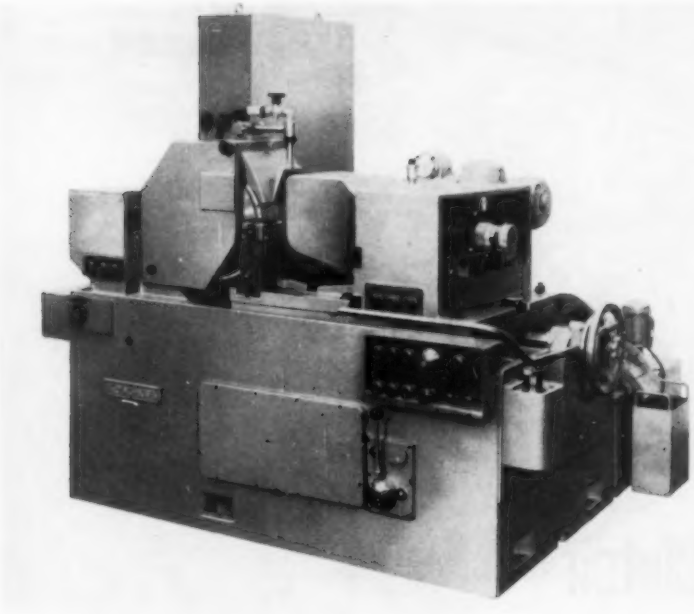
Dry process . . . is continuous—the roll of already developed negative keeps transferring its images to a roll of print paper by way of the rotating drum coated with photosensitive selenium.

Before it reaches negative, drum's selenium is given charge of positive electricity. Then the moving strip of negative briefly contacts the rotating drum and is exposed by slit of light at line of contact. Selenium exposed to dark areas keeps its charge; the rest is discharged.

Next, exposed section passes development electrodes where it is sprayed with finely dispersed, electrically charged black powder (in this case, charcoal). This powder is attracted to uncharged areas of selenium and repelled from the charged areas—thus leaving an image on the drum.

Finally comes moving contact with the plastic-coated paper, which is charged electrically to attract powder off the drum. This powder is permanently imbedded in the plastic surface by the fuser which momentarily heats the passing paper, softening the plastic.

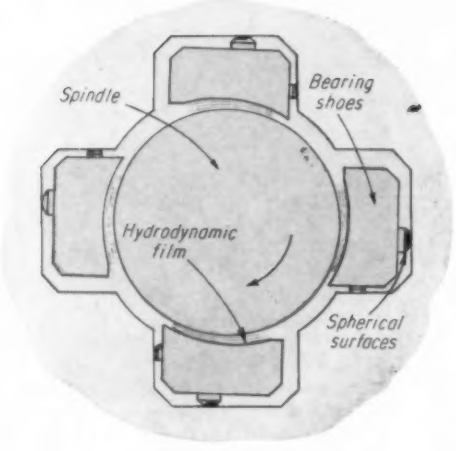




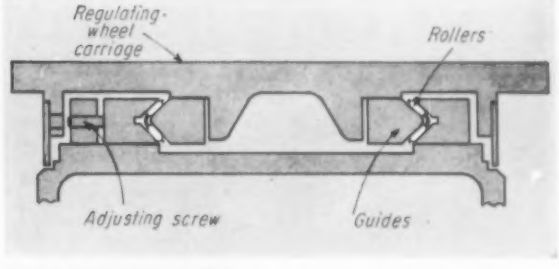
Floating Bearing Adjusts Itself

The centerless grinder from Germany has zero-play for wheel slides and bearings. A single control knob gives infinitely variable speed that provides optimum work speeds.

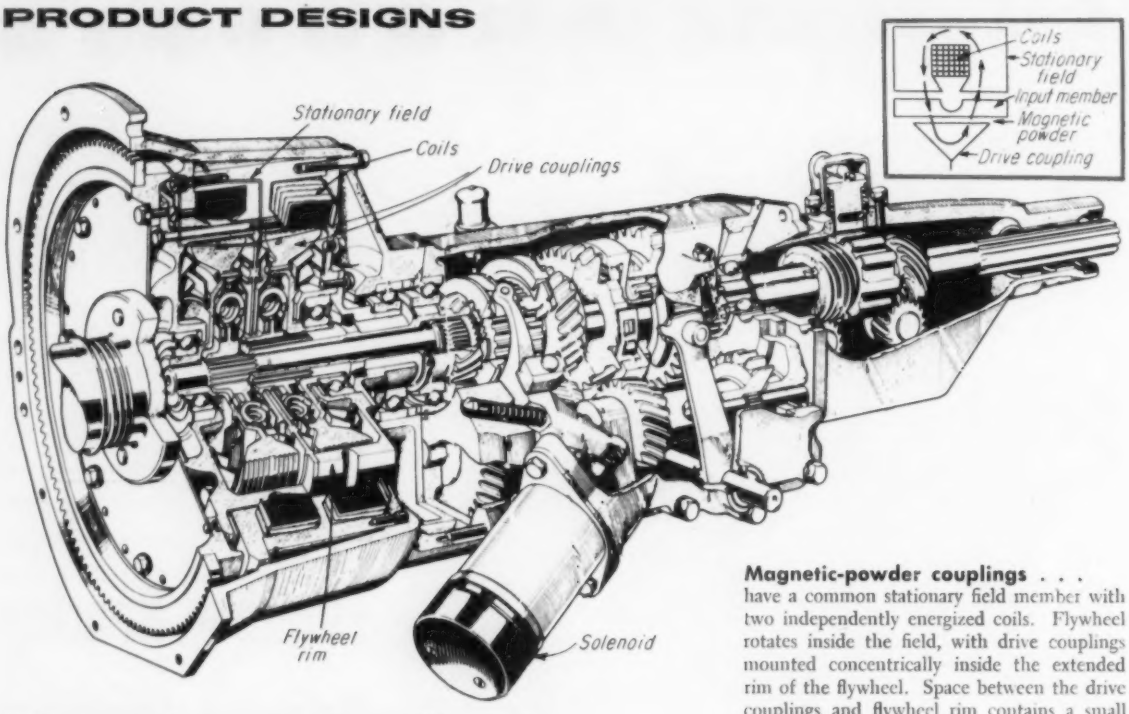
Capable of handling stock from 1/16 to 5 in. dia and from 1/16 in. to 20 ft long, the grinder holds diameter tolerances to 0.00015 in. and roundness to 0.000035 in. Grinding wheel is driven by a 27-hp motor; the regulating wheel by a 1.5-hp motor. SR4 Centerless Grinder is produced by Herminghausen-Werke GmbH, Hannover-Wuelfel, W Germ.



Bearings . . .
for both grinding and back-up wheel spindles are self-adjusting for the full range of work from heavy roughing to fine finishing. Bearing shoes are supported radially by a spherical surface and adapt themselves automatically to load changes. High hydrodynamic pressures, acting on the bearing shoes while running, clamp the spindle hydraulically. In comparison with these pressures the load exerted by the grinding action is so small that for practical purposes there is virtually no spindle deflection. Main motor circuit includes a lube oil-pressure switch—the reason why oil pressure to bearings must be available before the grinder can be started.



Regulating-wheel slide . . .
is roller-mounted to provide minimum, uniform friction. The guides are adjusted to give zero play and the roller tracks are hardened and ground. A split-feed screw nut is used and backlash is eliminated by spring loading. This provides accurate followup of the wheel slide when small feed increments (0.00005 in.) are applied.

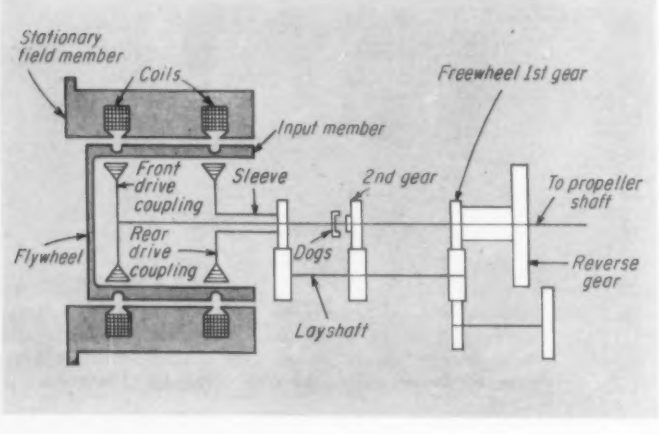


Magnetic-powder Clutch Drives Car

Automatic transmission from England combines twin magnetic-powder couplings with conventional gearbox. Electrical control system is responsive to road speed and throttle opening also provides full power shifting.

Low-cost transmission system for 1-to-2 liter (60-120 cu in.) engines is directly connected to run differential under normal drive conditions for increased efficiency. Produced by Smiths Motor Accessories Div, London, Eng.

Magnetic-powder couplings . . . have a common stationary field member with two independently energized coils. Flywheel rotates inside the field, with drive couplings mounted concentrically inside the extended rim of the flywheel. Space between the drive couplings and flywheel rim contains a small quantity of powder which behaves viscously under influence of magnetic flux generated by the coil. Density of the powder depends on the excitation current; torque transmitted is roughly proportioned to the current.



First-gear drive . . . is by the rear coupling through the layshaft and back to the mainshaft. Smooth starting is achieved by modifying the feed to the field coils of the car's generator so that output increases with road speed. For other speeds the coils are energized by the battery.

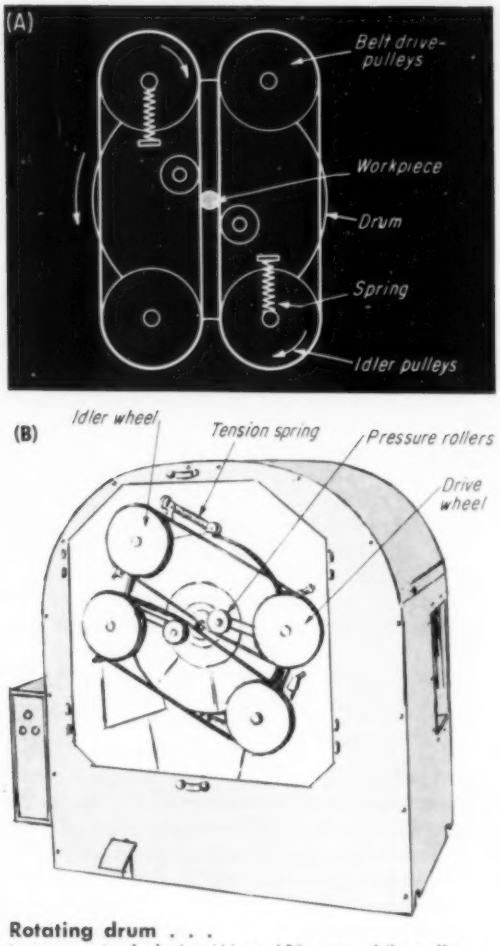
When the governor selects second gear, rear coupling is released and the forward coupling and second gear energized. A solenoid activates the dog clutch, locking the second gear to the mainshaft. This simultaneously de-energizes the forward coupling and re-energizes the rear coupling which drives in second gear. Freewheel in the first-gear pinion permits it to overspeed.

Top gear is engaged by energizing the forward coupling and de-energizing the second-gear solenoid, the dog clutch being spring-loaded to release. Reverse is manually operated and driven by an indirect coupling.

Revolving Drum Saves Abrasive Belts

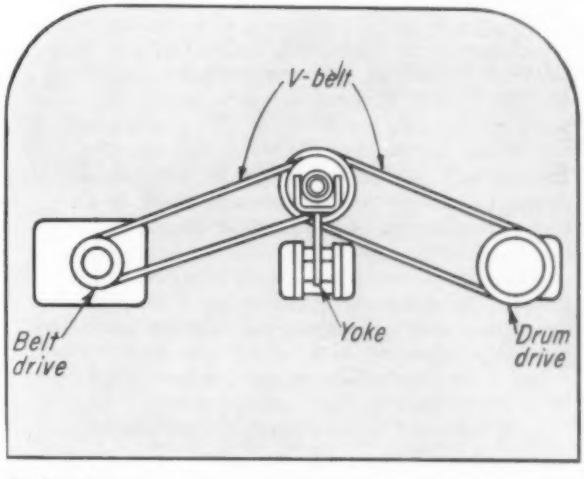
With compound motion of this German grinder-polisher, the belts wear uniformly and last longer. Drum method also eliminates need to rotate workpiece. Steady hand is only skill required by operator to achieve ready-to-plate polished surface.

Round, oval or tapered stock up to 3⅛ in. dia can be ground or polished. Cabinet encloses all moving parts, plus the collection system for dust removal. Single control is foot pedal which controls grinding pressure. Semiautomatic "Greif UR-1" is produced by Greif Werk GmbH, Hagen-Haspe/Westfallen, W Germany.



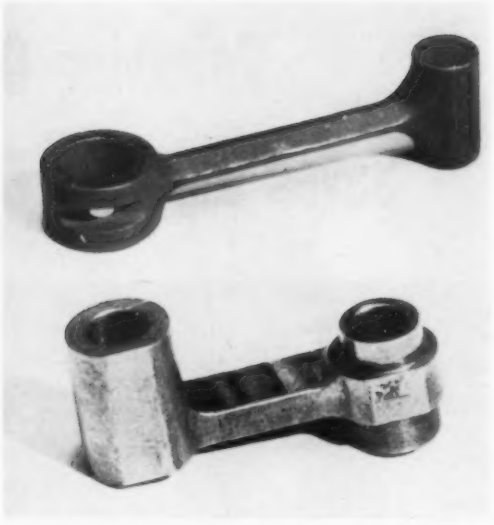
Rotating drum . . .
turns counterclockwise (A) at 138 rpm while pulleys drive abrasive belts at 90 fps clockwise. Pressure rollers (B), operated by foot pedal, bring abrasive belts into contact with work. Polishing is accomplished by moving work steadily in and out of machine, while pressing foot pedal. Variation in the diameter of tapered or oval bars is offset by belt tension springs on idler pulleys.

Flexibility of abrasive belts allows greater contact with the workpiece. Hollow drum spindle permits polishing straight stock of unlimited length and curved stock up to 20 in. long.



Back view . . .
of polisher, with cabinet removed, shows separate drives used for drum and belts. Yoke on hollow shaft is part of linkage between foot pedal and pressure roller linkage.

Although investment casting and sintered metal powder seem competitive for making small mechanical parts, a closer look usually shows the choice is easy once you know what the part must do.



Push-pull makes the difference when specifying production method for these links. Top: high speed, long throw and thin section called for investment casting. Bottom: shorter link designed for rigidity at moderate speeds was made by powder metallurgy.

how to choose—

INVESTMENT CASTING or SINTERED POWDER

LLOYD E RAYMOND, *senior process engineer*
The Singer Manufacturing Co

Shape tells only part of the story. Even when two techniques can give exactly the same shape to a link or gear, one way is usually superior. This is especially true when deciding whether to make a small mechanical part from an investment casting, or from sintered metal powder. The choice will depend mainly on the job facing the part—because each process will impart different mechanical properties.

And if the process does not show clear-cut advantages in properties, there is usually enough difference in costs to guide the decision. But differences must be examined closely. For example, the unit price of a sintered compact may be from one-sixth to one-hundredth that of an investment-cast part. But in low quantities, the advantage is lost. Die costs for compacting may run from two to 40 times the die costs for molding wax or plastic patterns with the investment-casting method.

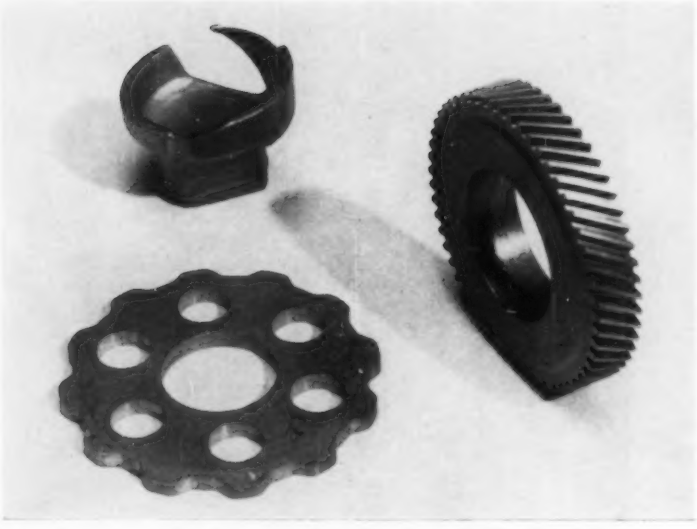
High-speed applications usually call for investment castings. The reason can be seen in linkages and reciprocating parts—the low inertia necessary for their rapid acceleration has to come from reduced mass. And smaller mass or cross-section means high stresses that tend to eliminate a sintered part. Also, investment castings have higher impact and fatigue properties.

By contrast, porosity of the powdered-metal part can be controlled to hold oil for self-lubrication. Also, its reproducible close tolerances are better than those of investment castings.

Choice then depends upon service and cost. After the process is chosen, initial designs should be reviewed to include minor revisions that will facilitate manufacturing and cut cost.

Geometry Affects Choice

The shapes of sintered metal parts are almost unlimited in the plane normal to the direction of pressing. This



Where problems lie . . .
in designing small mechanical parts. It's a matter of reproducible dimensions vs versatility in shape. Both the helical gear and cam disk have close dimensions: 55-tooth gear with helix angle of 31° 42′ was pressed and sintered to finished shape without grinding of gear teeth surfaces; center hole of cam is concentric to outer surface within 0.002 in., cam rise is held to within 0.001 in. and hole diameters to within 0.0015 in. Complex sewing hook, upper left, has less critical dimensions; its undercuts and shape dictate an investment casting.

includes holes of varying contours. But minimum wall thickness is dictated by ability of the punch to withstand compacting pressures of 50 tons per sq in. Sharp edges in parts must be replaced by small flats 0.006 to 0.010 in. wide. Top and bottom punches should not meet. This can show up as a small parting line. Undercutting is discouraged, and holes not in the direction of pressing are usually impractical because they give trouble when the green compact is withdrawn from the die.

The investment-casting process, by contrast, is rarely limited by the geometry. It can cast undercuts, back draft, curved passageways, angular holes, compound angles. The limit is usually small holes below ⅛ in. into which the investment will not flow.

Comparison of Tolerances

The powder-metallurgy part may be held to very close tolerances on the contours. Limits of ±0.0005 in. are the rule. Thickness in the direction of pressing is harder to govern and a tolerance of ±0.003 in. in this direction is usual (in exceptional cases, closer limits can be held). If thickness is critical, grinding the flat surface can hold tolerances easily.

The general tolerance for investment casting is usually ±0.006 in./in. with minimum of ±0.003 in./in. Sometimes ±0.002 in./in. may be held. Concentricity is better in the powder techniques than in the casting techniques.

Dimensional tolerances are more reproducible in the powdered-metal part and therefore inspection procedures here need less sampling than in the investment casting.

Which Is Cheaper

The reason why unit price of the sintered compact can be so much less is because production pressing, sintering, coining and resintering, may be made completely automatic. In normal press operations, the production per press will run from 300 to 3600 parts per hour.

The investment method is slower because it has more processing steps. It is more flexible and thereby permits irregular shapes, but this, too, increases the unit cost. Automatic handling of investment casting is not usually considered feasible.

On the other hand, tooling costs for investment casting are quite low because unhardened steel, aluminum or soft metal dies are used to make the wax pattern. It is even possible to produce soft metal dies by pressing a cast master into a lead alloy. These dies, however, cannot be used to injection-mold polystyrene patterns.

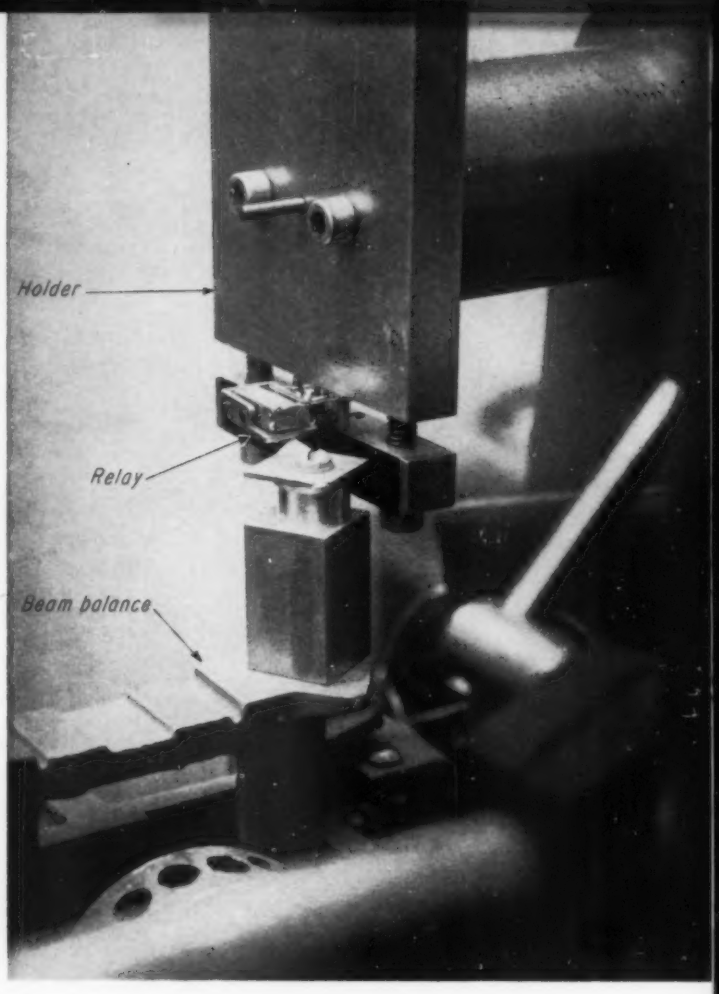
Powder-metallurgy tools, by contrast, must be hardened and lapped, with clearance between the punches and dies held to within 0.0002 in. With less clearance the tools will gall; with more, fine particles of powder become wedged between the punches and the die. This is where the tooling cost for powder-metal parts can run up to 40 times the comparable cost in investment casting.

EDITOR'S NOTE: Other recent articles on powder metallurgy and competing processes for small mechanical parts are covered in:

"Powder Metallurgy CAN Compete with Stamping," May 11 '59, p 82, tells how the powder technique can lower cost for thin sheetmetal parts that require secondary finishing.

"Slip Casting . . . Its Field Broadens," Oct 13 '58, p 84, discusses the slurry casting method which is giving intricate cast shapes to powdered-metal parts; tells how it stacks up against other powder processes and where it's headed.

"Design for Metal-powder Parts," Aug '57, p 183, supplies basics on how to design small parts specifically for this production process.



Spring and magnetic forces are measured separately or in any combination by removing or adding such relay components as return and contact springs. Relay tester has sensitive, fulcrum-mounted beam balance that measures force at each increment of armature travel.

testing tool helps write

RELAY SPECIFICATIONS

It's a simple 5-step procedure. Testing a standard relay supplies data with which you can specify a new design that will faithfully meet special needs.

T ROSS WELCH
Telecomputing Corp, Los Angeles

Until very recently, there was difficulty predicting just how a newly designed electrical relay would operate. This led to an excessive margin of safety for its critical parts, because failure of any such part means total failure of the relay.

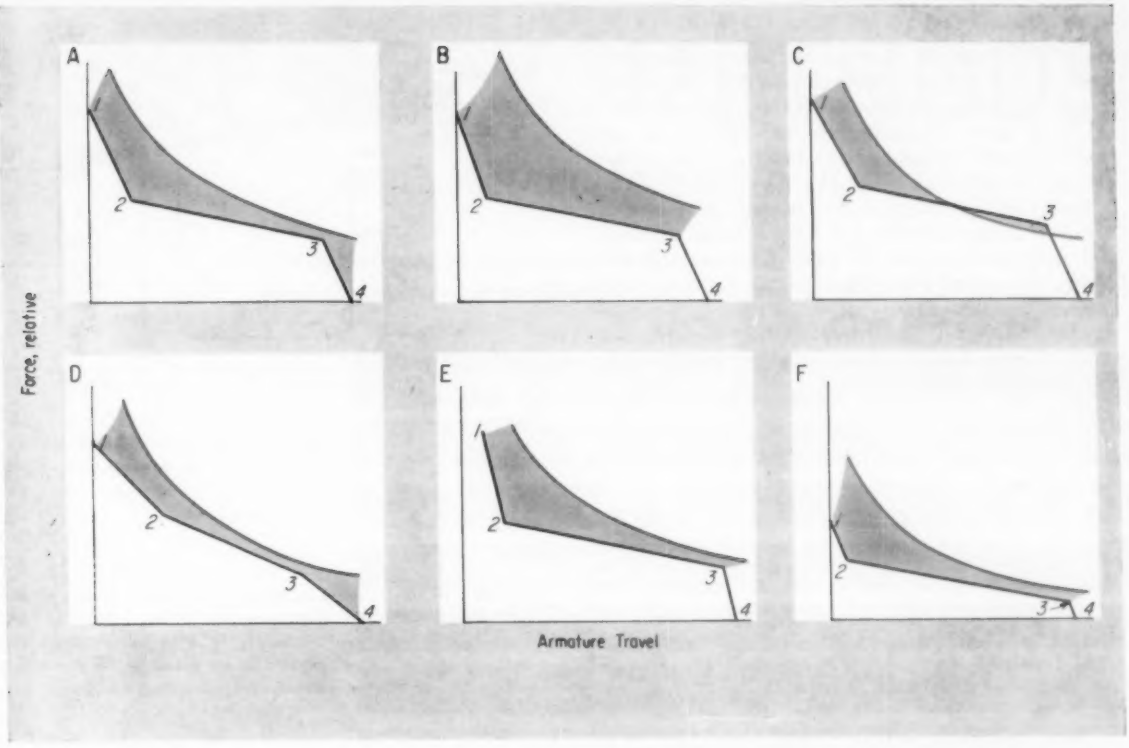
That situation has changed–we can now separate and determine the forces available in a relay to move its contacts against spring loads plus friction. Result: desired performance is insured, without the extra cost that comes from over-design.

It is done by starting with special tests of an existing relay, then predicting the design changes it needs. These are changes the manufacturer is able to try out quickly–he can now build and test a prototype relay in as little as one day, instead of the two weeks needed formerly.

The pre-prototype procedure breaks down into five steps:

- Obtain an available relay similar to the type needed.
- Instrument it with test equipment described here (such "force-function" equipment was introduced at last year's Electromagnetic Relay Conference).
- Measure forces and position in a series of small steps to learn the actual force margins available.
- Predict changes in force levels needed to give desired performance.
- Submit specification sheet with suggested force margins to the manufacturer.

The second step is easy with any relay that can be force-instrumented as illustrated above. Such test equipment can be designed and built in an engineering model



These different relays . . .
show approximate variation in force margins affecting performance. Force readings are assumed taken on armature at position above actuating coil. In each case, colored curve is magnetic driving force; lower, broken line is resisting spring force. Portion between breaks 2 and 3 is where movable contacts are in airgap and have not touched stationary contacts; contact overtravel is from 2 to 1 and 3 to 4, adding (or subtracting) the effective spring force of contact arm. Pattern (A) gives satisfactory performance because: adequate force margin exists at all points; spring forces have right proportions—30% change from 4 to 3, 10% from 3 to 2; 60% from 2 to 1. The other plots each demonstrate one fault: (B) magnetic-force margin too great; (C) magnetic forces too low; (D) too much overtravel; (E) too little overtravel; (F) contact loading too small.

shop, but it is wiser to purchase it from a qualified instrument manufacturer.

The last three steps (measuring, predicting, submitting specifications) should be a joint effort between design engineer and relay manufacturer. The final design may well end as a compromise between the ideal and the practical.

The same test method can later give indication of how the relay lasts in service. Before-and-after tests accurately show contact wear, loss of magnetic strength, increase in bearing clearnace, and fatiguing of springs. Compensations can be made accordingly.

WHAT TO LOOK FOR

Any relay must move with rapid, sure motion, and retain adequate contact pressure in both energized and de-energized positions. And margin must be left for normal wear, change of characteristics of the relay materials, and sluggish behavior of some voltage supplies.

Magnetic force must always be higher than spring force to give a positive margin. If the application will involve vibration, then the spring force and magnetic ampere turns can be further increased . . . the tests predict how much. If power supply is limited, ampere turns and spring load can be reduced to give performance that is just satisfactory and no more.

An inadequate force margin can result in slow movement that accelerates contact failure. Fortunately for many poorly designed relays, the magnetic forces improve slightly as the pole faces wear in (flatten by pounding against each other); this can balance out a limited drop in performance elsewhere.

Extreme overtravel can overstress a flexible contact arm to point of fatigue. Conversely, if original overtravel is too small, contact erosion can reduce effective value to the point where electrical contact is lost. As a corrective measure, increasing the overtravel without increasing total travel is possible if the airgap can be shortened. However, electrical potential across the airgap required by an application may limit the minimum for airgap distance; the only solution then is to increase overtravel and total travel.

TAKING THE MEASUREMENTS

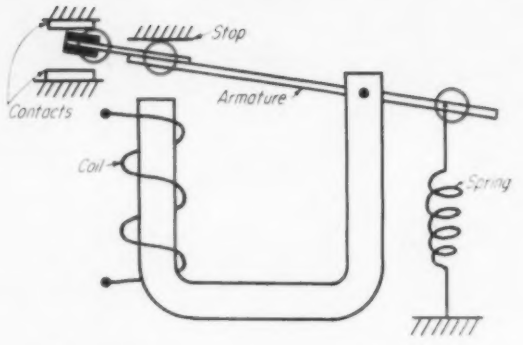
Testing can be simple. In the apparatus illustrated, the relay is held in a jig and voltage is applied to the

coil. The armature is set to the desired incremental position, and its force is measured on the beam balance. Force and position measurements are plotted concurrently on an x-y coordinate plotter. Movement increments of 0.0002 in. can be easily detected, as well as force changes of 0.5 grams.

Each reading is taken in static balance; dynamic measurements are not possible with such a simple technique. But static tests will usually prove conservative because inertia in an actual relay will aid in carrying the contacts through trouble spots.

These important parameters can be measured: magnetic force exerted on armature; resisting force of return spring; resisting force and strain of contact arm assembly; pretravel, overtravel, and wipe of contacts; contact force; and bearing friction. Concurrent readings are taken of voltage and current to the coil to augment the force data and help calibrate the test setup. Additional data, such as contact resistance, can be obtained for special applications.

Even analytical designers of relays are accepting this basic test method; it serves to eliminate the unknowns of static force vs position for each relay component. And transients and side effects can now be more easily separated for study—using different tests—because they are no longer confused with the principle forces.



Relay measurements . . .
taken at one or more points indicated by colored circles are adequate for most tests. For special requirements, take readings at any practical position along the armature or on the springs. Strain gages can be added too.

EDITOR'S NOTE: A previous article, "This Money-saving Guide Tells How to Size Up Electromagnetic Relays," Nov 24 '58, p 66, outlines all steps necessary to write specifications for standard relays. Also included is an index to 15 preceding articles on relays, that answer most selection problems.

let's have an
ENGLISH DECIMAL SYSTEM of MEASUREMENT

G G LIPS
Julianadorp, Curacao, Dutch West Indies

The most expensive technical error made by English-speaking people was adoption of the English system of measurement—by short-sighted politicians and businessmen of Napoleonic times 150 years ago. It would cost too much now to change over to the metric system, but it is not too late to start adopting an English "decimal" system. This would mean new teaching, new methods, new books and new scales—but no change in tools, machines and instruments.

For linear measurements we can start with the "mil"—0.001 in.—and introduce a new series of designations for both larger and smaller units:

Unit	Value	Abbrev.	Symbol
Micro-inch	10^{3}	Mikin	mk in.
Milli-inch	(base)	Milin	m in.
Kilo-inch	10^{3}	Kilin	k in.
Mega-inch	10^{6}	Megin	M in.
Gega-inch	10^{9}	Gegin	G in.
Tera-inch	10^{12}	Terin	T in.

Conversion factors for these new units would be:

Mikin = millionths of an inch
Milin = mils (thousandths of an inch)
Kilin = inches
Megin = 5/6 of a foot
Gegin = about 1/16 mile
Terin = about 63 miles

Addition of "square" and "cubic" terms to these factors will give units for area and volume.

By the same method a decimal series for weight can be set up based on a "dram"; and the "second" would serve as the basic measurement of time. Thus one set of related basic units could express velocity, pressure, acceleration momentums, energy, power and mass with complete elimination of conversion factors. Conversion to metric measurement would require only a few handy factors.

(For more about difficulties of converting to the metric system, see *PE*—*May 11, p 28*—Ed.)

ASSEMBLY METHODS

. . . *an engineering roundup*

A solid package of illustrated how-to's that will solve some tough assembly problems or spark answers to others.

joining sheet-metal parts without fasteners

joining circular parts without fasteners

fastening from one side only

assembly by twisting

fastening flexible sheet material

aligning assemblies with only one screw

attaching glass to metal

fastening small die-cast parts

liquid-tight riveted joints

brazed joints

spring-steel fasteners simplify assembly

characteristics of reinforced plastic joints

designing for assembly

checklist for assembly methods

A Product Engineering special report

DOUGLAS C GREENWOOD
associate editor

Low-cost, efficient and ingenious assembly of products accounts for much of our success as an industrial nation. Yet the search is always on for **even better assembly methods,** whether to reduce costs or improve reliability. As in most engineering progress, the process of finding the better method is one of evolution.

But **to spark the inventive processes** that yield the new idea there must usually be a catalyst; two or more assembly methods—even though quite different—can then combine to produce **a completely new and better method.** The catalyst in all design-engineering problems is experience and recallable knowledge.

A treasurehouse of material dealing with assembly has appeared in the pages of PRODUCT ENGINEERING. It represents the **combined experience of many top engineers.** This valuable material, plus ideas and suggestions from many companies, **has been distilled and is presented here in this special report.** It provides both a solid package of practical how-to's, and the catalyst for further progress through new ideas.

Each of these idea starters points to the **three-fold nature of a fastener problem.** The fastener itself is only one part of the design; the two parts being fastened are also parts of the problem. **Selection of the fastener** depends on the function the parts are required to perform.

▶

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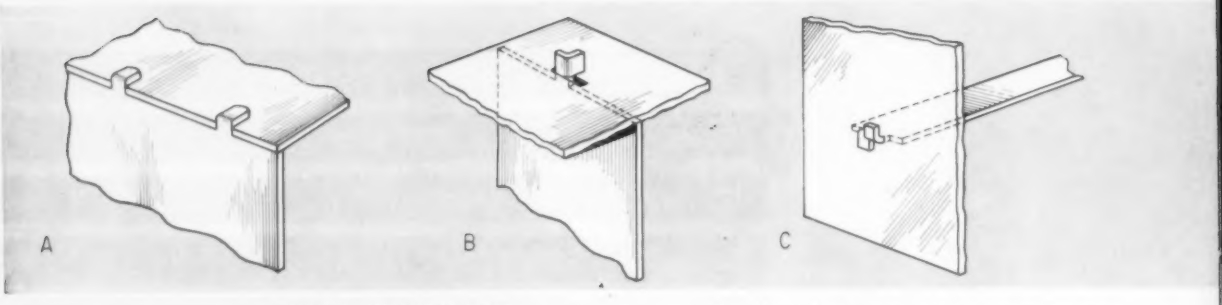
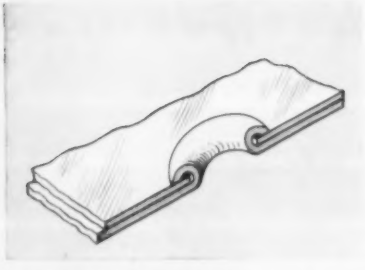
joining sheet-metal parts without fasteners . . .

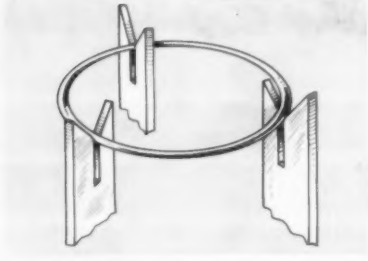
Here are some methods for attaching sheets, rods and tubing in permanent or temporary assemblies without using bolts, screws or rivets.



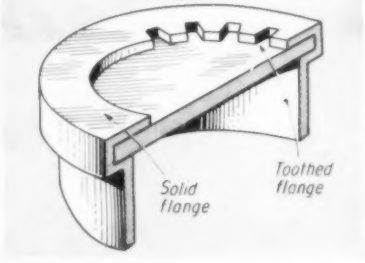
BUTTED SHEET-METAL PARTS . . . *at or near 90° require two or more tabs (A); single, twisted tab or tabs (B) help when fastening is not easy to get at for machine tab-bending. Greater rigidity is provided (C) by split tab.*



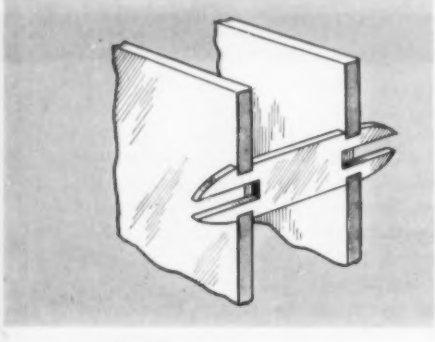
PERMANENT ATTACHMENT . . . *of parallel sections requires rolled-over material to be quarter hard or softer.*



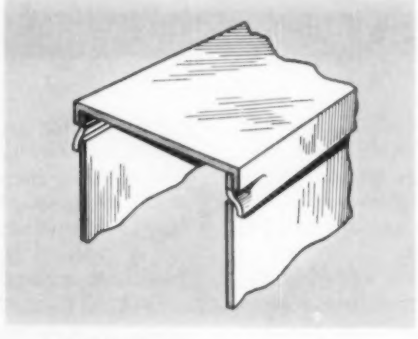
TEMPORARY . . . *support of rods or tubes. Support jaws are sprung open during installation and removal.*



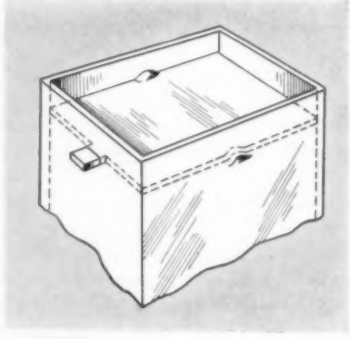
END-CAP . . . *on cylindrical part can be more easily removed when held by toothed flange than by solid flange.*



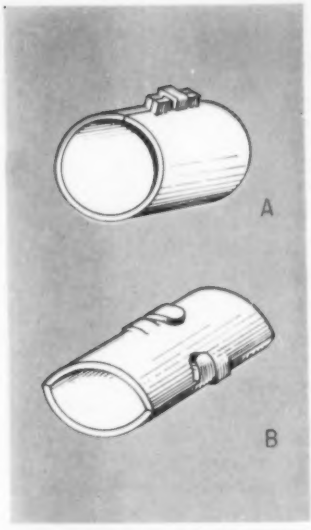
SPACER . . . *for two sheet-metal walls may be freely removed unless forked ends are squeezed over tab in slot.*



BOX-COVER . . . *tabs snap into notches in channel or box, hold cover with positive action.*

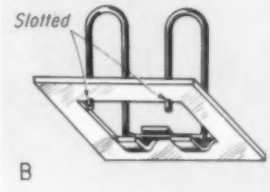


RECESSED . . . *plate in rectangular housing is held by dimples and tab.*



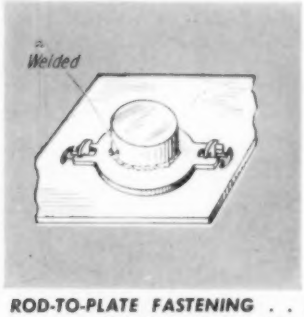
ROLLED TUBE . . . *has tab integral with sheet (A) one tab is larger than the other and is bent over on assembly. Elliptical section (B) also has integral tabs. For best results tabs should be adjacent to each other as shown.*

LAP-JOINTED . . . *tube must be kept in tension to maintain efficient fastening.*



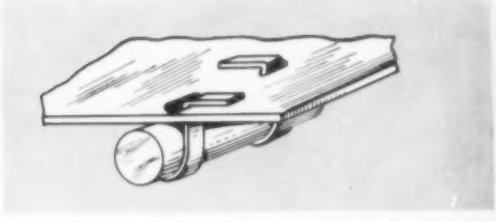
TABS AND BRACKET . . . *support rod at 90° to plate; bracket is welded to plate. Slots (B) hold rod in place. For mass production, tabs and slots may be stamped; for limited production, hand-formed.*

joining circular parts without fasteners . . .

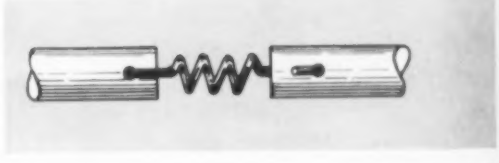


ROD-TO-PLATE FASTENING . . . *is accomplished by first welding the rod to small plate that has slotted ears. Tabs in bottom plate are then bent and twisted.*

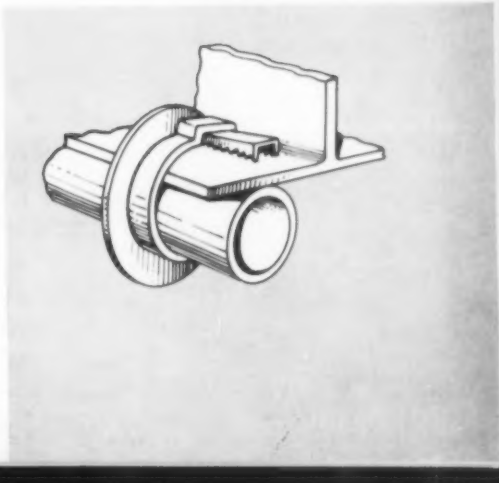
RODS AND TUBES . . . *can be supported by sheet-metal tabs. Tab is wrapped around circular section and bent through plate.*



SPRING . . . *joins two rods or tubes. Members are limited in axial motion or rotation by spring strength.*

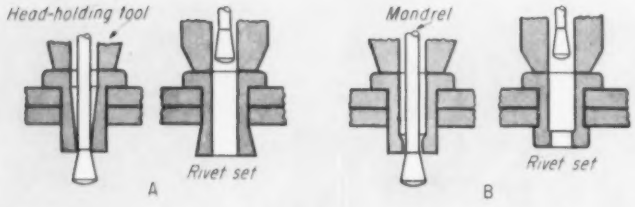


C-CLAMP SUPPORT . . . *is ideal for tubing. Serrated wedge is hammered tight; serrations prevent wedge from working loose.*



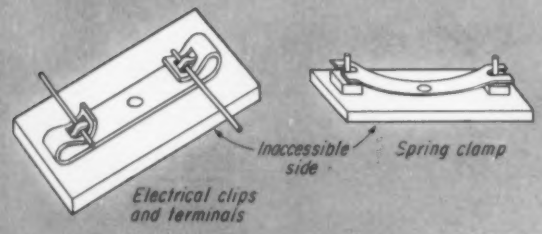
fastening from one side only . . .

Screws, nails, adhesives, etc., are well-known fasteners which require only one side of an assembly to be freely accessible. Rivets conventionally require two free sides—one for the rivet-setting anvil and one for the punch. Special rivets that can be set from one side, however, are available in many different designs. Generally the methods used to expand the blind rivet-end are three: screws, mandrels and explosives.

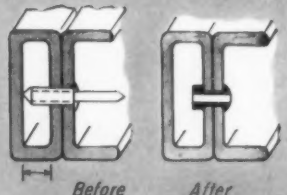


TYPICAL BLIND-RIVET . . . *design is the Chobert-type rivet, developed originally in France and now available from many different manufacturers. The mandrel may be pull-through type as shown here, or plug type, which is pushed into the rivet. Here the rivet takes the form of a flanged bushing with tapered (A) or two-dia hole (B). Mandrel upsets the blind end when withdrawn.*

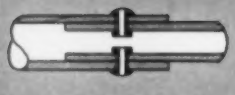
SOME TYPICAL EXAMPLES . . . *where blind-side fasteners, especially rivets, can be used to advantage.*



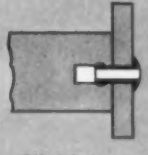
Tubes and headers

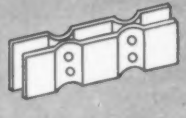


Structures with blind access or limited back clearances

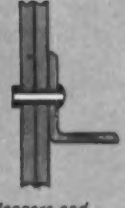

Structural tubing

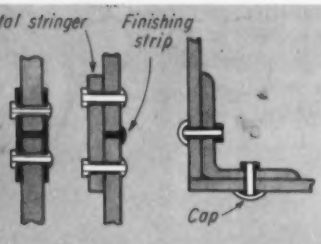
Extrusions


Blind holes


Laminated ducts

Structures with limited side clearances


Hangers and brackets

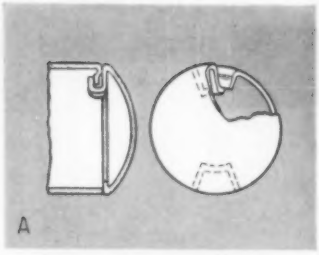


Side walls and panels

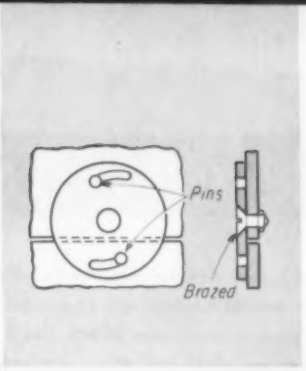
Multiple assemblies

Metal panels to wooden framing

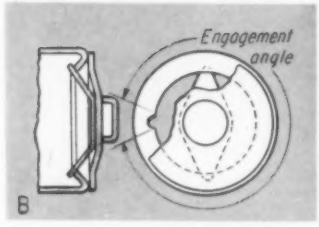
Plastic or wood to metal



COVERS FOR CYLINDRICAL VESSELS . . . *are held tightly by (A) flanges that grip on slow-wedge principle when cover is engaged and rotated. The same principle can be used in (B) where*

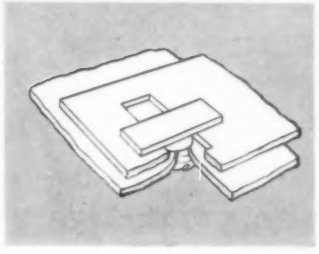


SPIRAL SLOTS . . . *force pins to pull elements together. Recesses at ends serve for locking.*

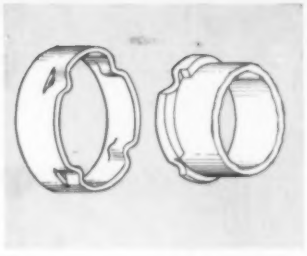


parts that assemble and lock by twisting . . .

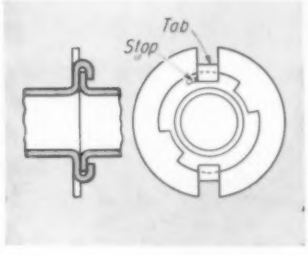
elongated tabs fit under lip in vessel—notch allows assembly. Large angle of engagement makes a slow wedge less necessary.



TWIST LOCK . . . *here represents basic principle of many quick-release fasteners—third member twists to lock two plates together.*

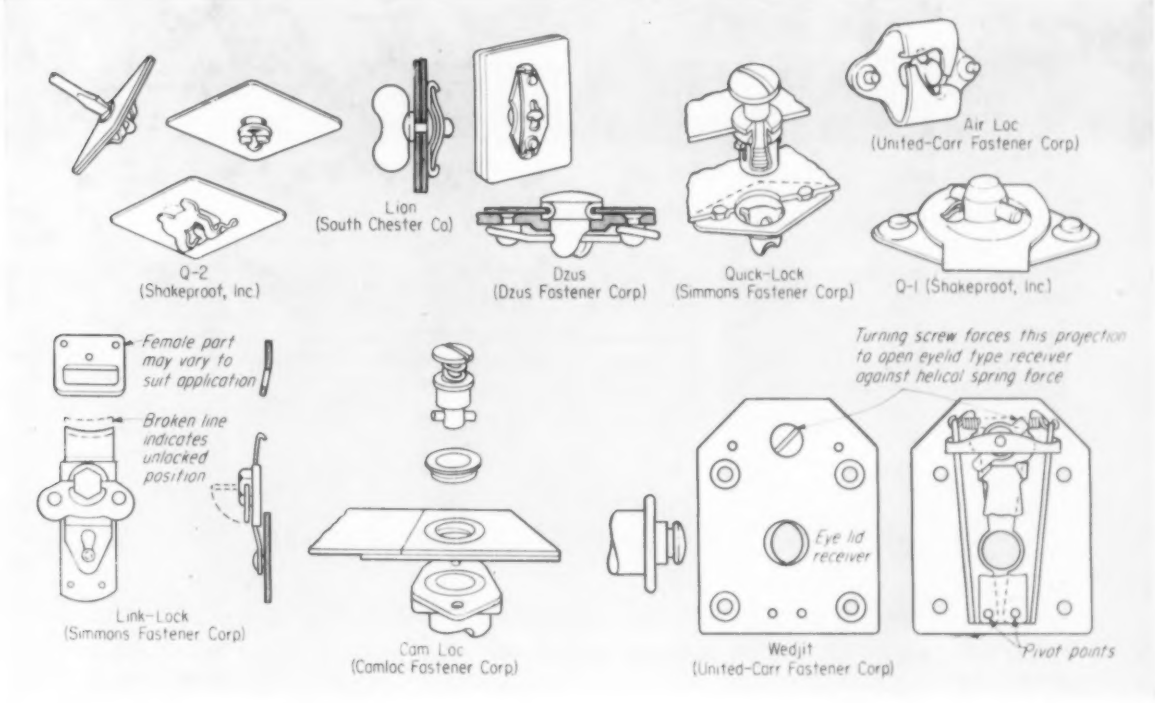


FORMED PROJECTIONS . . . *on cover slip over recesses in flange of cylindrical vessel. Tapered flanges ensure tight grip when cover is twisted.*



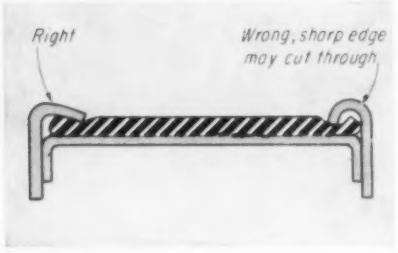
EQUAL-DIAMETER TUBES . . . *are joined by engaging tabs in slots and then twisting. Assembly can be made and taken apart quickly without having to bend tabs each time.*

QUICK-RELEASE FASTENERS . . . *are configurated below. They all engage or disengage with a partial twist—in contrast to fasteners that require several turns for complete engagement.* ▼

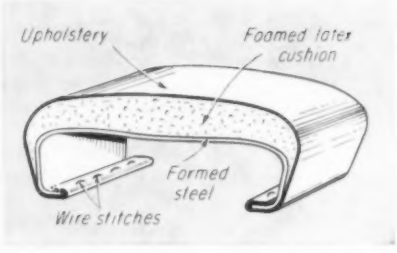


fastening flexible sheet material . . .

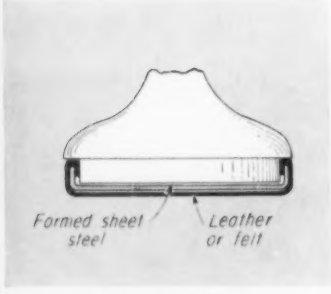
Although adhesives and sewing are by far the most popular methods, they are too commonplace to be given much attention here. When using other methods, clinch the fastener over as large an area as possible by using washers, grommets, eyelets, or molding strips. Similarly, sharp corners should be avoided, particularly where the material is subject to tension or repeated flexures at the joint. Free edges should be protected to prevent fraying, curling, or catching on pointed objects.



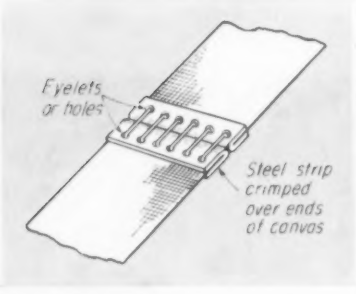
Crimping to hold rubber.



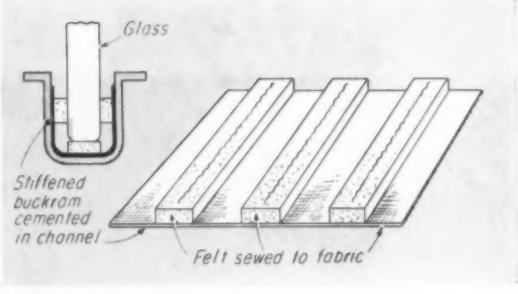
Covering foam rubber, e.g. seats, padded surfaces.



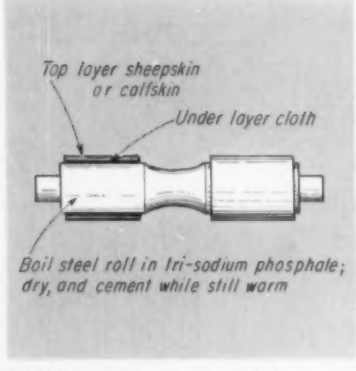
Instrument base



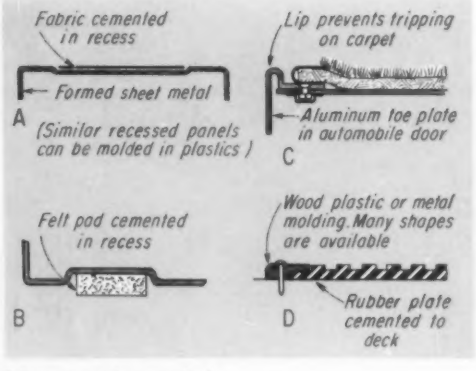
Canvas conveyor belt



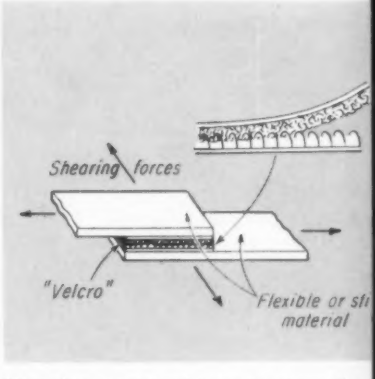
Felt window-guide


Top layer sheepskin or calfskin
Under layer cloth
Boil steel roll in tri-sodium phosphate; dry, and cement while still warm

Padded roller, e.g. top roll for spinning frame.

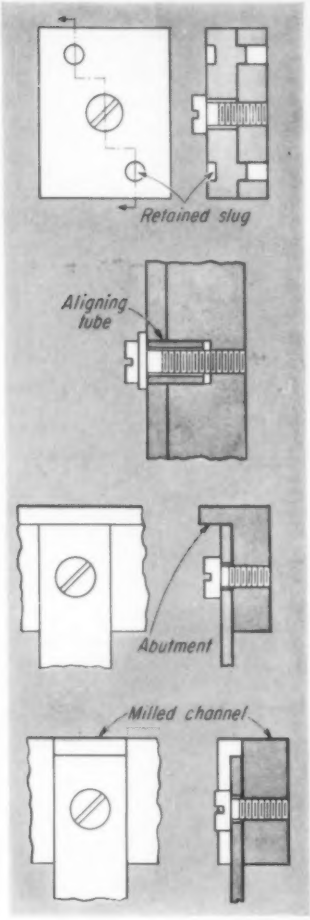

Fabric cemented in recess
Formed sheet metal
A
(Similar recessed panels can be molded in plastics)
Lip prevents tripping on carpet
Aluminum toe plate in automobile door
C
Felt pad cemented in recess
B
Wood plastic or metal molding. Many shapes are available
Rubber plate cemented to deck
D

Edge-protection methods.



"Velco" material withstands about 5 psi in shear.

Two Flat Parts

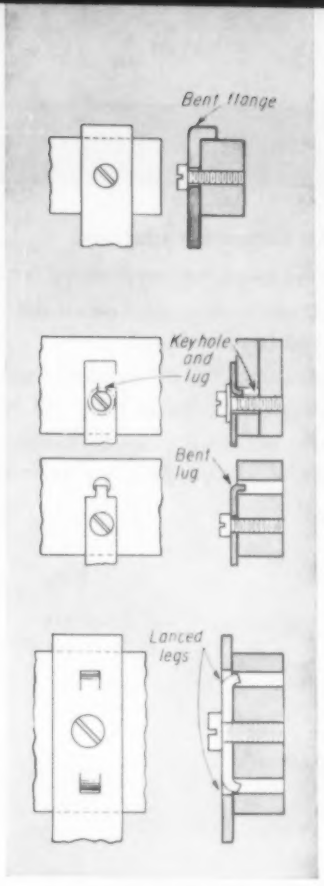


RETAINED SLUGS . . . *act as pins, perform same function as dowels; are cheaper but not as accurate as dowels.*

ALIGNING-TUBE . . . *fits into counter-bored hole through both parts, allows max screw-clearance without effecting alignment.*

ABUTMENT . . . *provides positive, low-cost alignment of rectangular part.*

MATING CHANNEL . . . *milled in one part gives more efficient alignment than abutment in preceding method.*



Formed Stampings Assembled with Flat Parts ▲

BENT FLANGE . . . *performs similar function as abutment, but may be more suitable where machining or casting of abutment in large part is not desirable or practical.*

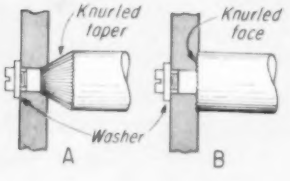
BENT LUG . . . *(bottom) fits into hole, aligns parts simply and cheaply; or (top) lug formed by slitting clearance hole in sheet metal keys parts together at keyhole.*

TWO LEGS . . . *formed by lancing, align parts in manner similar to retained-slugs method, but formed legs are an alternative for sheet too thin to partially extrude lug.*

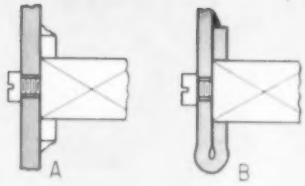
aligning assemblies with only one screw . . .

Flat Parts and Bars

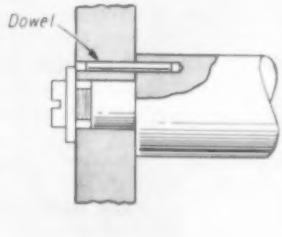
KNURLED END . . . *of round bar (A) has taper that digs into edge of hole when screw is tightened; thus gives accurate angular location of bar or sheet. (B) Radial knurling on shoulder is even more positive if mated with knurling on plate.* ▼



DOUBLE SHEET-THICKNESS . . . *allows square or hexagonal locating-hole for shaft end to be provided in thin sheet. Extra thickness can be (A) welded or (B) folded.*



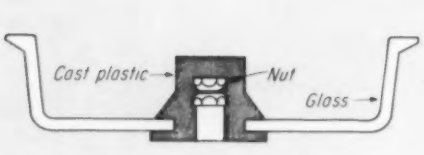
DOWEL . . . *is simple, efficient method of preventing rotation if rod dia is big enough.*



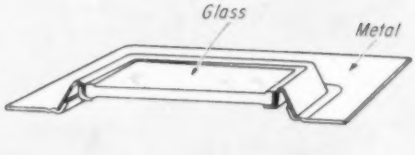
how to attach glass to metal structures . . .

General recommendations

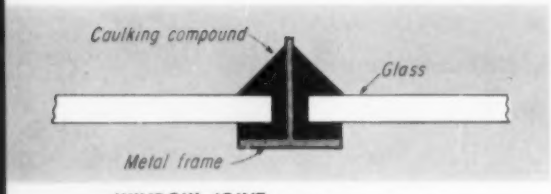
- **Design glass for compression loads.**
- **Load glass uniformly—watch out for stress concentration caused by gasketing.**
- **Compensate for differential expansion. Glass has an expansion range from 1.8 to 5.0 x 10–⁶ in./°F.**
- **Mount unloaded glass on flexible support so that loads on the structure are not transmitted to the glass.**



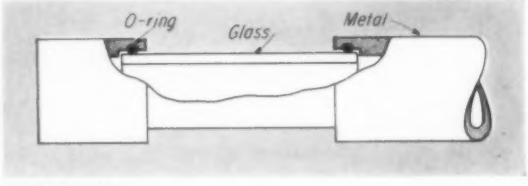
CAST PLASTIC HUB . . .
acts as link between glass and threaded metal insert; suitable for moderate loads only.



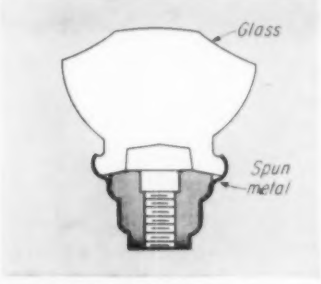
SOLDERED GLASS . . .
has metallized edge for soldering. Frame is semi-rigid to absorb differential expansion.



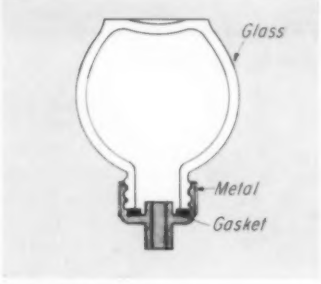
WINDOW JOINT . . .
requires caulking compounds and cement to make liquid-tight seals with metal frames.



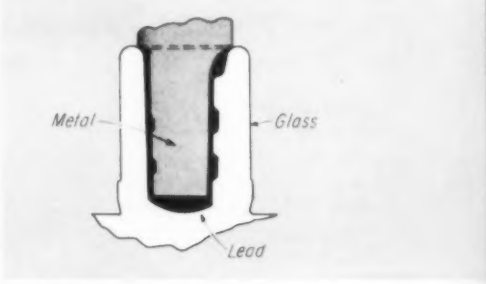
O-RINGS SEAL . . .
glass tubing to metal fixture. Shoulders in metal tubes retain glass member in proper place.



SPUN METAL JOINT . . .
for light loads has thin metal sheet spun around a glass shoulder to form an attachment.



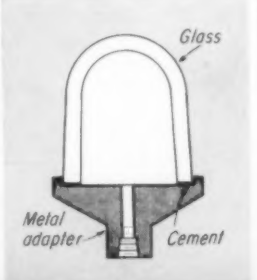
THREADED JOINT . . .
for low-pressure applications has threaded glass container screwed into metal fixture.

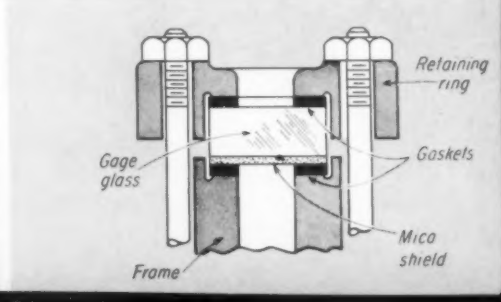


PERMANENT SEAL . . .
employs poured lead to lock metal arbor to hubbed glass part. Use is restricted, however, to moderate loads and temperatures.

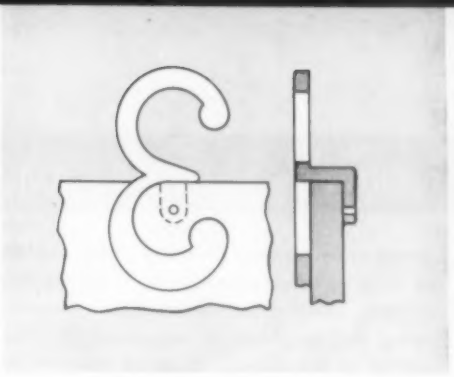
CEMENTED (right) . . .
joint is shown in this container, which carries explosive down oil wells. Internal suction creates extra holding power for glass.

GAGE GLASS (far right) . . .
of water-level column of a steam boiler uses mica shield to protect glass from corrosion by alkaline boilerwater.

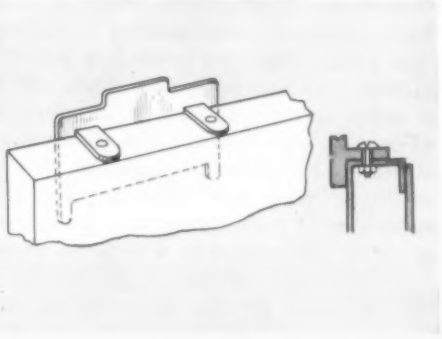




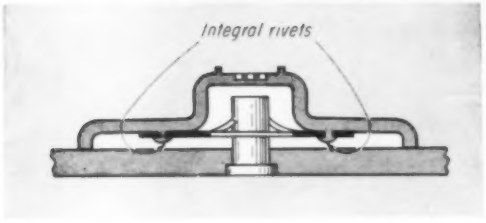
OFFSET INTEGRAL LUG . . .
is so located that it can be molded without need for moving mold-core. Screw hole can be cored if desired. Thickness of material on which the lug fits should be held to plus 0.000, minus 0.010 for consistant rigidity of attachment. When thickness is likely to vary too much a screw may be necessary.



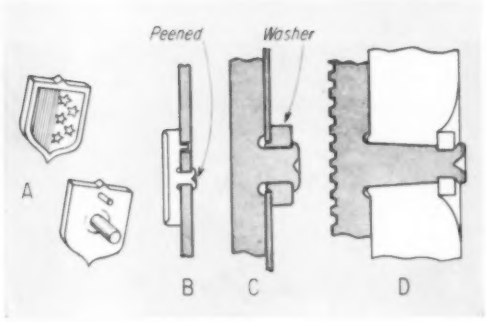
FLAT INTEGRAL LUGS . . .
are applicable where the trim extends beyond edge of the part to which it is attached. It is not usually economical to core the holes in the lugs; they can be drilled or punched if the lug is 0.080 in. or less in thickness. These lugs can be used for attaching trim to wood, fiber, or molded plastic, and sheet metal (with a bolt and nut) if part is formed to a box section as in small sketch. This method is commonly used for display stands and vending machines.



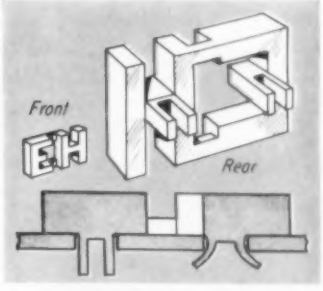
6 ways to attach small die-cast parts . . .



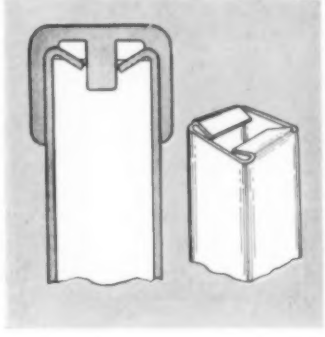
◀EXTENDED SPEED CLIP . . .
is attached by integral rivets to the underside of the trim and is forced over a stud projecting from the main part of the assembly. After being pushed over the stud, trim is given a quarter turn to tighten down the clip. This is advantageous only when rear of assembly is inaccessible, and service is not severe. If the trim is circular, the stud can be threaded.



INTEGRAL, RIVETED STUD . . .
is one of the most widely applicable fastening methods. When thickness of the material is not less than diameter of the stud, it can be peened as shown. If the material is thin, a washer (C) or (D) is recommended, since short studs are severely stressed by heading. It is always advisable to specify a filleted channel around studs, to reduce stress concentration. Hard fiber washers may be used where vibration might cause chatter. Small pieces of trim held by a single stud need some means, like another stud, of preventing rotation.



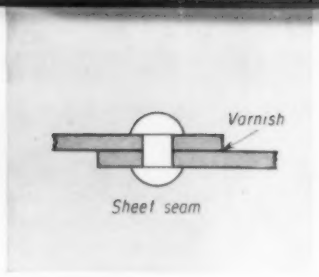
RECTANGULAR LUGS . . .
projecting from the rear of the trim, pass through a square punched hole in the casting and are peened in place. This gives a sturdy assembly and is preferred to riveted round studs that project from the surface and are susceptible to failure or damage by accidental impact.

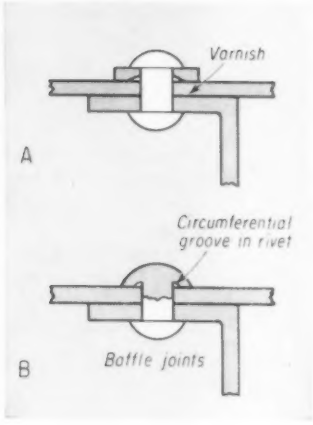


DIE-CAST COVER . . .
for elastic materials, such as steel or brass. Ends of the tube are cut, sheared, and turned inward at an angle of 10-12°. Cover has a projecting lug of rectangular section; when cover is forced on, the lug passes between the turned-in tangs and presses them inward, resulting in a spring locking force.

liquid-tight riveted joints . . .

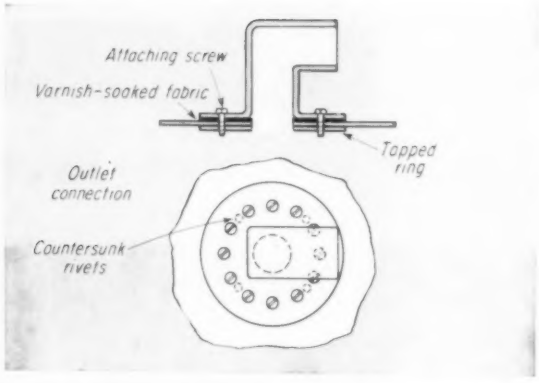
Correct rivet-spacing plus a suitable sealant are the keys to liquid-tight joints. Fuel tanks, for example, can be sealed with an oil-resistant, slow-drying, heavy phenolic resin varnish. This is applied at the seams. In some cases a gasket of varnish-dipped cotton tape or cork is included. Before joints are assembled all contacting surfaces, rivet holes, rivets and screws are coated with the varnish. The riveting is done while the varnish is tacky. Loctite sealant, a liquid plastic that hardens to form a tough oil-resistant bond between metals, is also an ideal compound for these situations. Water-tight joints may be made in the same way as fuel-tight joints. Domet flannel or cotton tape soaked in a water-resistant soy-bean oil varnish, silicone or marine glue is used at corners and complicated joints. Fastenings shown here are all able to withstand 15 psi.

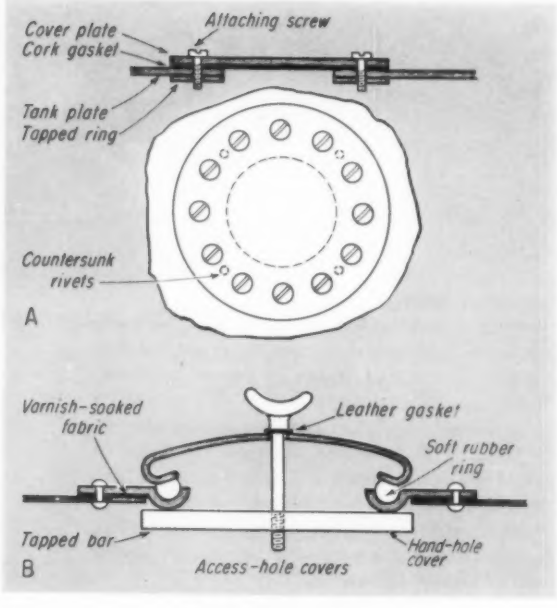


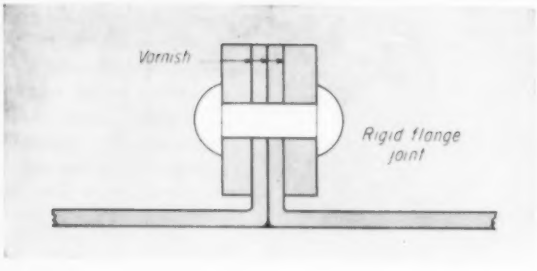


LIQUID-TIGHT RIVET SPACING
Aluminum-alloy Roundhead Rivets

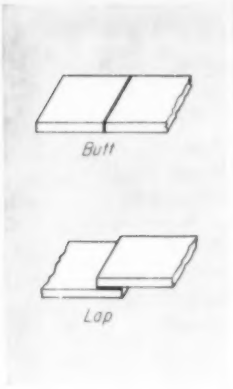
Smallest Plate Thickness	Rivet Diameter	Edge Distance	Pitch, Single Row	Pitch, Double Row	Distance between Rivet Rows
0.023"	3/32"	1/4"	3/8"	13/32"	5/16"
0.029	3/32	1/4	3/8	13/32	5/16
0.036	1/8	5/16	1/2	9/16	13/32
0.045	5/32	3/8	5/8	23/32	1/2
0.051	5/32	3/8	5/8	23/32	1/2
0.064	3/16	3/8	3/4	1 3/32	1/2
0.081	1/4	15/32	1	1 17/32	5/8
0.100	5/16	19/32	1 1/4	1 15/16	25/32
0.125	3/8	11/16	1 1/2	2 5/16	15/16
0.187	1/2	27/32	2	3 3/32	1 1/4
0.250	5/8	1	2 1/2	3 7/8	1 9/16

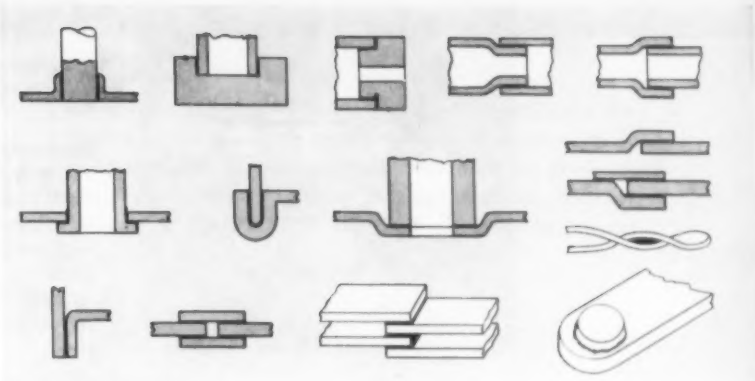






OVERLAP . . .
of three times the thinnest member will usually yield 100% lap-joint efficiency. Butt members are limited to the cross-sectional area of one member.

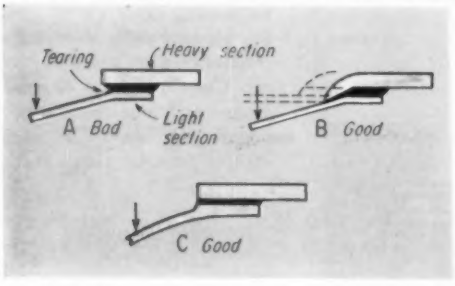




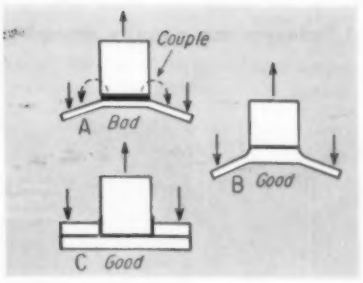
AN ASSORTMENT . . .
of lap and butt joints. T-sections and corner joints are considered to be variations of butt joints.

8 hints on brazed joints . . .

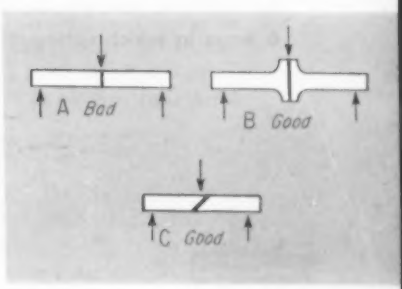
Some dangers—and how to avoid them



HIGH STRESS . . .
and consequent tearing of braze (A) will be caused by load on joint: Shape the heavy section as in (B), or increase the light section (C) to prevent tearing.

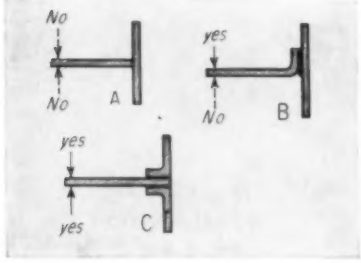


COUPLE . . .
causes torn joint (A): Increase the light section (B) or redesign (C) to strengthen joint.

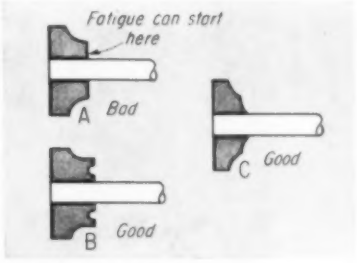


IMPACT . . .
causes joint failure (A): Increase the braze area (B) or use a scarf joint (C) to improve the impact characteristics of the joint.

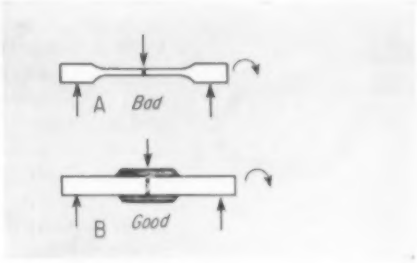
Some design hints



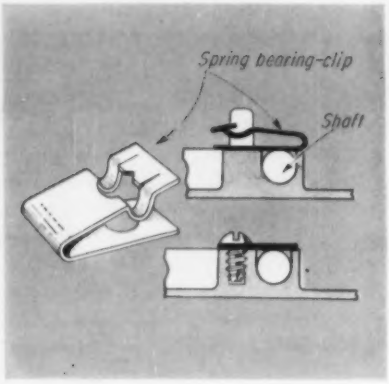
T-JOINT (A) . . .
will fail under loading in either direction while corner joint (B) can take one-direction load, and (C) with stiffened cross-section, handles two-direction loading.



HUB AND AXLE (A) . . .
will fail by fatigue at joint. Designs (B) and (C) permit hub to follow flexure of axle because of undercut or generous hub radius.

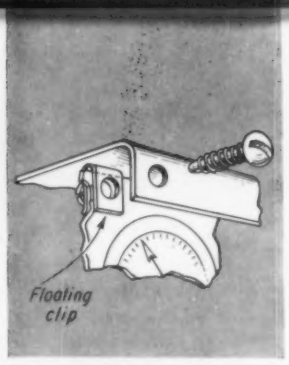


ROTATING BEAM (A) . . .
will have a low fatigue life while sleeve (B) will increase this life. Even if sleeve is not brazed in place, it is still a good safety feature.



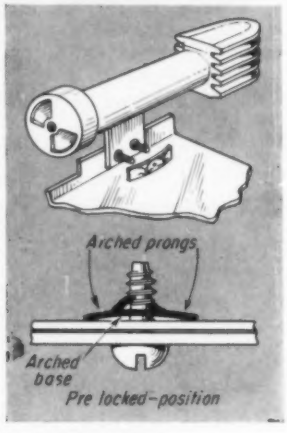
BEARING CLIP . . .
holds shaft in channel, allows rotation and replaces screw and retaining-plate.

FLOATING CLIP . . . ▶
snaps in place by hand, cures problem of hole misalignment by permitting sufficient shift of mounting holes to offset normal manufacturing tolerances of main parts.

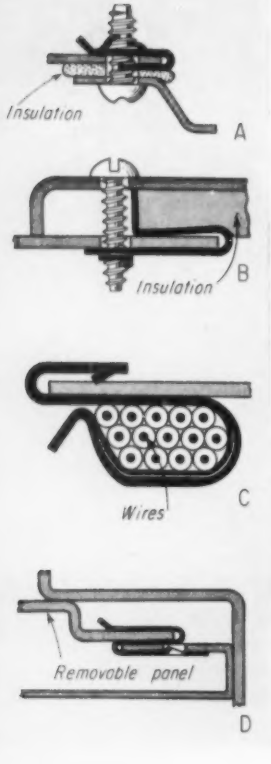


spring-steel fasteners simplify assembly . . .

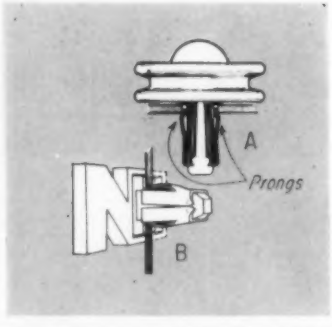
Annealed spring steel can be stamped, twisted, or bent into any desirable shape and then heat-treated to develop spring characteristics. It can, therefore, be designed for multiple functions as well as for fastening. Here are 6 ways in which spring-steel fasteners can simplify assembly.



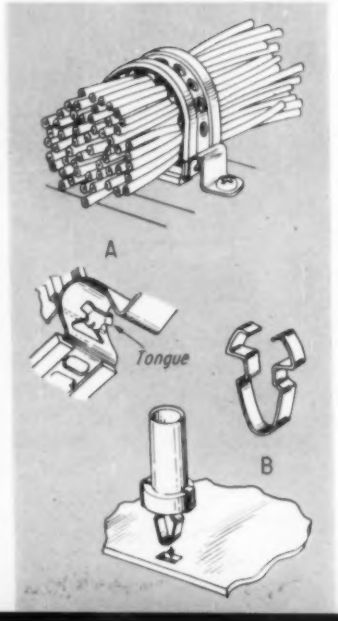
TWIN-HOLE UNIT . . .
in hard-to-reach location replaces two units and lock washers. Combined force of arched prongs and base when unit is compressed creates high resistance to vibration loosening.



END-CLIPS . . .
pushed by hand on panel edges have barbed retaining leg that either bites into metal or snaps into a mounting hole. Applications: (A) sheet-metal screw and S-clip with arched prongs compresses insulating material between panels; (B) bent leg of clip acts as spacer between two panels, supports insulation; (C) barbed-leg clip retains wires without need for mounting hole; (D) S-clip secures removable panel in inaccessible positions.



TUBULAR CLIP . . .
has cam-like prongs that spring out after insertion to hold fastener in position. Applications: (A) radio-dial pulley; (B) attaching name plate to panel.



SPECIAL-FUNCTION . . .
fasteners for quick assembly and disassembly of components. (A) Wire harness clamp using tongue and slot principle; (B) dart-shaped clip for attaching coils and other parts to electronic chassis.

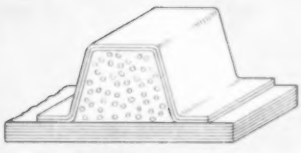
characteristics of reinforced plastic joints

When materials with different moduli are bonded together, special conditions are produced by stressing the adhesive in shear. These conditions can sometimes be counteracted by bonding laminates of different thicknesses; using thicker section for lower modulus material. Below are shown 9 joints used in assembling reinforced plastics.

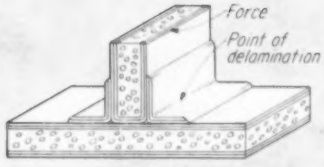
Laminate
Reinforced by fabric, paper or mat

Wood
Hard or soft

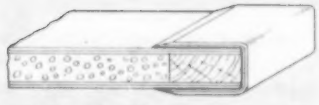
Core material
Foamed cellulose acetate, polystyrene, phenolics or rubber, honeycomb



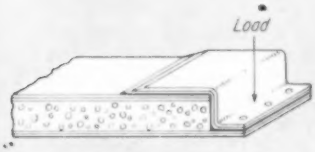
RIBBED LAMINATE . . .
When reinforced-plastic parts are not sufficiently stiff (because of a thin section or because of a flat shape), ribs can be added to prevent collapse.



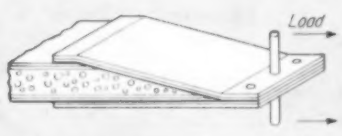
SURFACE RIGHT ANGLE . . .
Sandwich panels joined in this manner do not have the weakness of grooved horizontal panels. The top surface of the horizontal panel is not disturbed and retains its full strength. Excessive horizontal forces on vertical panel can cause delamination.



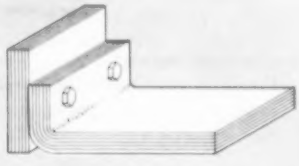
HIGH-DENSITY INSERT EDGE . . .
Any high-density material can be used as the edge insert for this joint. When wood is used, further assembly can be done by screwing through the laminate and anchoring in the wood. The channel section can be made of light metal.



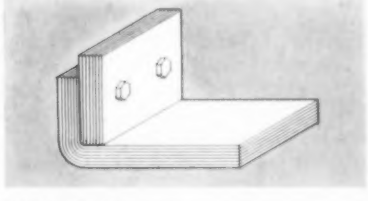
FLANGE EDGE . . .
Here the two skins of the sandwich have been tied together and a flange provided. This type of edge is particularly useful when loaded as shown in the sketch.



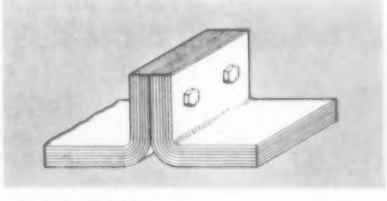
WEDGE-SHAPED EDGE . . .
This is an edge that provides a very strong joint where the loading is to be along the plane of the panel. Generous lap areas are provided when it is necessary to transmit large tensile loads to the skins of the sandwich.



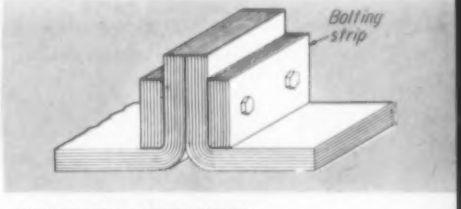
OUTSIDE CORNER . . .
The outside corner joint is stronger than a corner butt joint because of the additional bonding surface, but it also is weak against bending stresses. It is particularly good for horizontal compressive loads.



INSIDE CORNER . . .
This joint is good for carrying horizontal tensile loads. When bonding supplements bolting, the bolts provide clamping pressure as the adhesive sets. Also, the excess adhesive fills the voids in the bolt holes.



90° FLANGE . . .
Tensile loads on horizontal laminates of this joint would cause peeling because the load is applied eccentric to the bolts. This same loading tends to produce bending at the angle and may result in delamination if the load is excessive.

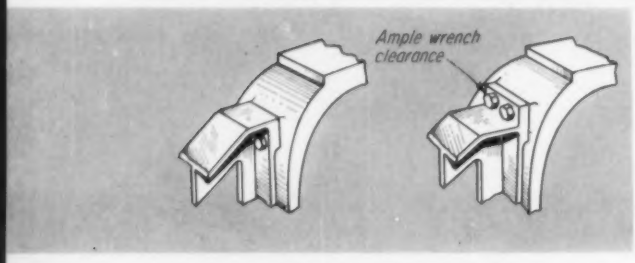


90° FLANGE WITH STRIPS . . .
Both the delamination and the peeling tendencies of the plain 90° flange joint can be avoided by adding bolting strips on both sides of the joint. If the bolting strips are bonded to the laminates, a strong joint is formed.

designing for assembly . . .

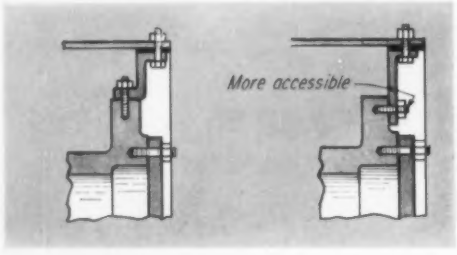
Careful attention to detail can pay off in easier assembly. Common design faults shown on this page represent some basic principles. Deceptively obvious when seen, the correct designs represent hidden gold in a finished product.

WRONG **RIGHT**

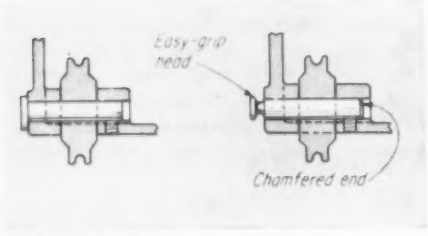


INSUFFICIENT WRENCH CLEARANCE . . .
has probably caused more delay and condemnation than any other fault.

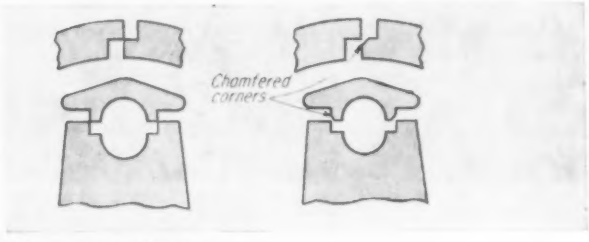
WRONG **RIGHT**



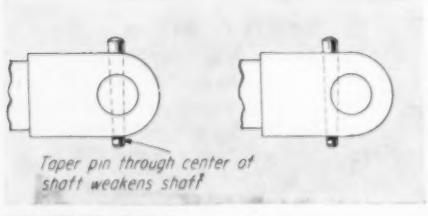
ACCESSIBILITY . . .
of bolts, as well as head-and-nut clearance, speeds assembly.



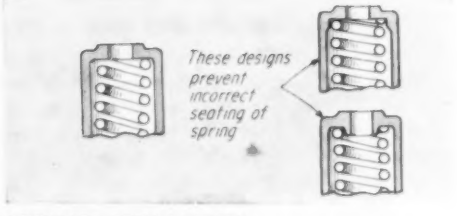
GRIPPING MEANS . . .
should be provided where frequent pin-removal or other handling will be carried out.



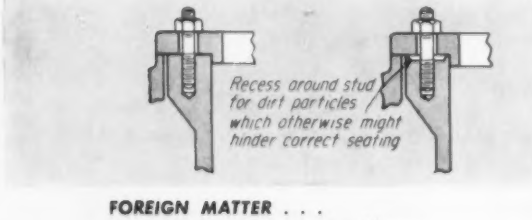
CHAMFERED CORNERS . . .
facilitate rapid assembly.



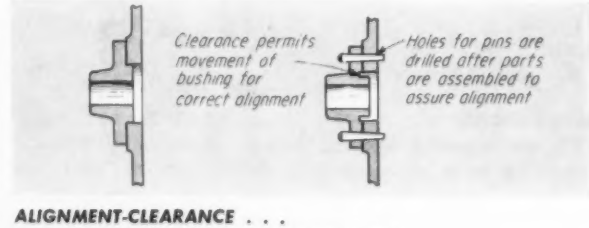
WEAKENED PARTS . . .
such as drilled shaft can often be avoided by better design.



ACCURATE SELF-LOCATION . . .
of parts is a big help in assembly.



FOREIGN MATTER . . .
is an enemy of close assembly—therefore watch all points.


Clearance permits movement of bushing for correct alignment
Holes for pins are drilled after parts are assembled to assure alignment

ALIGNMENT-CLEARANCE . . .
rears its ugly head whenever two or more locating points appear on the same part.

assembly checklist . . .

This classified list will give you a quick survey of basic assembly methods. Its purpose is to remind you of alternate methods—sometimes your very closeness to the problem hinders your thoughts and memory. This list will let you step back a bit and get a broader view, or even be a valuable tool for the creation of new ideas.

Threaded

1. Machine screw & nut
2. Machine screw into tapped hole
3. Threaded parts, i.e. rod, pipe, etc.
4. Self tapping
5. Lock-screws
6. Studs
7. Threaded inserts
8. Coiled-wire inserts
9. Drive screws
10. Plain washers
11. Lock washers
12. Threaded rivets
13. Special-function washers
14. Sheet-metal nuts
15. Clinch nuts

Rivets

1. Solid
2. Hollow
3. Bifurcated
4. Explosive & other blind-side type
5. Two-part *(male and female)*

Welding

New welding processes are constantly being developed to meet the challenges presented by new metals and requirements. Here are most basic methods, new and old, that are available today.

1. Oxyacetylene
2. Electric arc
3. Resistance welding *(all types)*
4. Inert-gas arc
5. Ultrasonic
6. Pressure (hot and cold)
7. Electron beam
8. Submerged arc
9. Magnetic force welding
10. Induction *(non-pressure)*
11. Electro-slag *(Russian development)*
12. Explosive force
13. Friction *(Russian development)*
14. Diffusion bonding
15. Foil seam

Soldering & Brazing

1. Soft
2. Hard *(brazing)*
3. Manual vs oven
4. Resistance fusing *(soldering-iron tip bridges work and heats by current flow.)*

Adhesives

1. Room temp
2. Hot
3. Air polymerizing

Friction-held

1. Nails
2. Dowels
3. Roll-pins, etc.
4. Shrink fits & press fits
5. Clamps
6. Binding
7. Taper pins
8. Spring clips
9. Keys

Interlocking

1. Twisted tabs
2. Twist-lock *(wedge)*
3. Snap on/in *(inc. snap rings)*
4. Twisted wires
5. Pierced & formed sheet metal *(two pieces together)*
6. Crimping

Miscellaneous

1. Peening
2. Flattened ends
3. Staking
4. Wiring
5. Split pins
6. Retaining rings
7. Push-on grip washers
8. Staples
9. Magnetic

SPECIAL CASES

Plastic

1. Heat sealing
2. Spin welding
3. Torch welding
4. Molded-in inserts
5. Hot-gas welding

Anti-vibration

1. Spring mounts
2. Elastomeric mounts

Gas & Water-Tight

1. Gaskets
2. Flow-on sealants

Double Duty

1. Electrical contact plus fastener
2. Decorative plus fastener

Shaft Couplings

1. Fixed
2. For axial play
3. Universal

Bearing Mounts

1. Plain
2. Anti-friction

SHOP HERE FOR MORE INFORMATION

A richly stocked store is little help if you don't know where the merchandise is located. Here's a guide to important assembly articles appearing in PRODUCT ENGINEERING *since 1955.*

1959

11 Ways to Couple Tubes, Mar 16, p 70
These Parts Carry Their Own Adhesive, Mar 2, p 57
The 6 Types of Corrosion: A Preventive Guide, Mar 2, p 67
Reliability of Electrical Connections, Feb 2, p 54
12 Ways to Retain Gaskets, Feb 2, p 64

1958

Which Adhesive for What, Mar 18, p 79
Equations Predict Chance of Misfit in Assembly, May 26, p 61
Shrink-fit Nomograph, Apr 14, p 85
Check-chart for Single-part Complexity, Mar 31, p 124
7 Basic Selectors for Parts, May 12, p 96
17 Wedge-action Assemblies, Mar 17, p 96
10 Ways to Mount Servo Components, Jan 6, p 86
We Threw Out Press Fits for Bearings, Jan 6, p 67
Cast-in Tubing, May 12, p 76

Design Is More Than Nuts and Bolts, Mar 10, p 33
Fastener Checklist, Mar 3, p 82
12 Ways to Retain Electron Tubes, Apr 14, p 82
17 Pre-assembled Fasteners, June 9, p 78
Metal Inserts for Plastic Molding, Apr 28, p 104

1957

Single-component Epoxy Adhesives, May, p 164
Grooves for Retaining-ring Assemblies, Jan, p 158
How to Design with Shims, Aug, p 164
Probability Applied to Assembly Fits, Nov 25, p 88
How to Design Involute Splines, Oct 28, p 75
Bolted Assemblies Design, Sep 30, p 79
How to Design with Shims, Aug, p 164
Fastening Studs and Pins to Plates, Mar, p 194
14 Ways to Fasten Hubs to Shafts, Aug, p 194
Miniature Self-Locking Screws, June, p 151
Stripping Strength of Tapped Holes, Feb, p 215
Taper Pins—12 Ways to Retain Them Positively, Nov 11, p 122
20 Tamper-proof Fasteners, July, p 176
Which Rivet to Use, Oct 28, p 97
Part II, Nov 11, p 125
Gasketed Joints for Electrical Equipment, Mar, p 183
13 Ways to Couple Fractional Horsepower Motors, Sep 30, p 120
Design Hints for Laminated Plastics, Jan, p 186
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Bolted Assemblies—High-temperature Design, Sep 30, p 79
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And here are some good books

Buckingham, Earle. *Dimensions and Tolerances for Mass Production.* The Industrial Press, 1954. 164 p . . . $8

Grabbe, Eugene M. *Automation in Business and Industry.* John Wiley and Sons, Inc, 1957. 611 p . . . $10

Jones, Franklin D. *Jig and Fixture Design.* 4th Ed. The Industrial Press, 1955. 406 p . . . $5

Laughner, Vallor H. and Augustus D. Hargan. *Handbook of Fastening and Joining Metal Parts.* McGraw-Hill Book Co, 1956. 622 p . . . $15

Lytle, Charles W. and Arthur F. Gould. *Manufacturing Equipment and Processes.* 3rd Ed. International Textbook Co, 1951. 759 p . . . Out of print.

Morris, Joe L. *Modern Manufacturing Processes.* Prentice-Hall, 1955. 566 p . . . $7

Niebel, Benjamin W. and Edward N. Baldwin, *Designing for Production.* Richard D. Irwin, Inc, 1957. 657 p . . . $8.40

Schaller, Gilbert S. *Engineering Manufacturing Methods.* McGraw-Hill Book Co, 1953. 607 p . . . $7.50

Thompson, T. G. and R. A. Peterson. *Illustrated Jig-tooling Dictionary.* Macmillan Co, 1947. 349 p . . . $1.95

To be published this fall: **Greenwood, Douglas C.** *Product Engineering Design Manual,* McGraw-Hill Book Co, 342 p

REPRINT of this article can be obtained for your reference file by checking No. E84 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 151.

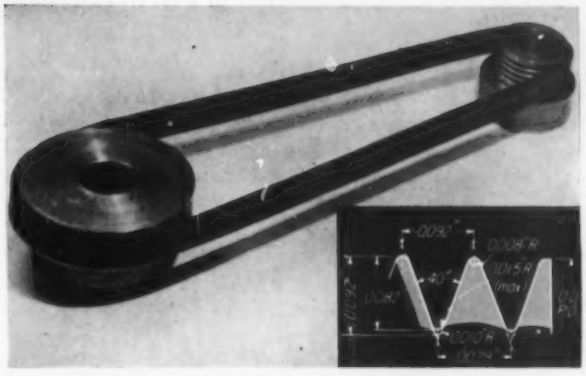
SIGNIFICANT COMPONENTS & MATERIALS

Nonradioactive phosphorescent paints . . .
are said to charge themselves from natural or artificial light and to provide a visible glow in nighttime. Manufactured in baking and air-dry formulations, paints are said to have good gloss retention and to be self-reactivating indefinitely. Baking type is primarily for metal surfaces; air-drying type is for materials such as wood, paper, plastics and plaster. White primer undercoat and clear finishing varnish are recommended for best results. **Ultra-Violet Products Inc, San Gabriel, Calif.**

Circle 1, Reader Service Card

Control valve has color-coded . . .
adjusting scale to simplify checking of valve setting, making quick adjustments, recording of readings and resetting. Color code is composed of permanently colored bands, each a different color. Color graduation system operates so that each full turn of screw exposes another color. In addition, screw is graduated numerically. Valves are suitable for use with air, oil, gas, water or other fluids. Standard models in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$-in. sizes withstand pressures up to 5000 psi. Guided poppet stem eliminates poppet cocking and seats accurately. Needle stop prevents needle from being backed completely out. Poppet stop prevents spring damage. Locking setscrew eliminates tampering by unauthorized personnel. All internal and moving parts are stainless steel. Valve bodies are available in brass, carbon steel or stainless steel. **Manatrol Corp, 2108 Payne Ave, Cleveland 14.**

Circle 2, Reader Service Card



Multi-V-ribbed, light-duty rubber belt . . .
is said to deliver power for fhp to 10-hp requirements with substantially smaller pulleys than a standard V-belt drive (*PE*—May 25, '59, p 19). Parallel V-ribs, molded lengthwise around inner circumference, mate with sheave grooves. Construction makes multiple V-belt drive performance available to light-duty drives for use over pulleys with min of 0.8-in. pitch dia. Sheave design distributes load evenly across full width of drive member and prevents belt from sinking into grooves. Inset shows typical cross-section. Belt is especially applicable to high-speed (10,000 fpm or rpm), small-pulley power transmission. Recommended for any belt drive except where variable pitch or adjustable sheaves are required or where positive speed ratios are essential. Available in 2 to 10 rib-widths (standard) in pitch lengths of 8 through 98 in. **Manhattan Rubber Div, Raybestos-Manhattan Inc, Passaic, NJ.**

Circle 3, Reader Service Card

Miniature slip-clutch gear . . .
absorbs shock of sudden stops in servo and instrument mechanisms. Prevents overload damage to gear teeth, bearings and components. Self-contained clutch is $\frac{7}{16}$ in. long and may be clamped to any 0.125 to 0.120-in.-dia shaft. Standard gears are 96 pitch, AGMA Precision I, and range in size from 66 to 110 teeth. May be preset to slip at any desired torque between 1 and 15 in.-oz. Gear is lubricated sintered bronze; body and spring are corrosion-resistant steel; clamp is anodized aluminum. $18 to $19.50 each. Delivery on standard sizes from stock. **Precision Mechanisms Corp, 577 Newbridge Ave, East Meadow, NY.**

Circle 4, Reader Service Card

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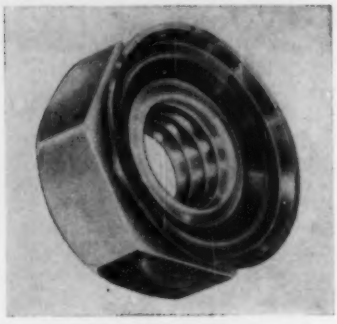


Preassembled fastener . . . combines spring washer with standard hex nut in unit that can be hopper-fed on automated assembly systems. Spring pressure is said to be exerted by cupped washer over greater reactive range than other types of preassembled nut and washers. Spring washer is free to turn, but is firmly attached to nut. Cupped washer is said not to mar surface to which it is supplied and can be filled with mastic for use as a sealing, liquid-tight assembly. Because of greater reactive range, washers are reported to keep bolted assemblies tighter longer by compensating for normal thread wear and bolt elongation. **Reliance Div, Eaton Mfg Co, Massillon, Ohio.**

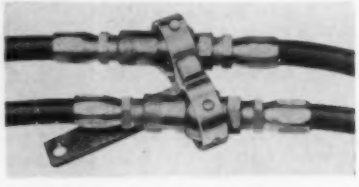
Circle 5, Reader Service Card

Temperature label . . . is backed with adhesive, and registers a permanent change from white to black as stated temperature level is reached. Will adhere under a wide range of exposure conditions until intentionally removed. Plastic label can register surface temperatures from 100 through 700 F in a choice of 50 increments, which tested indication accuracy reported to be 1%. Developed to eliminate cost, installation and maintenance problems of more complex temperature-recording devices in applications where excess temperature presents a hazard and must be detected. **Pyrodyne Inc, PO Box 49972, Los Angeles 49.**

Circle 6, Reader Service Card

Small tubing takes heat . . . Made from cold-drawn, precipitation-hardening stainless alloy that contains bolybdenum, and is offered with a wide range of mechanical properties. Standard annealed, half-hard and full-hard drawn tempers are available. Range is extended by two standard heat-treatment conditions, which may be performed after fabrication by the customer. Annealer tubing is readily fabricated, using procedures similar to those for Type 301 stainless steel. When welding, tubing does not need preheating or post-annealing. Annealed tubing also withstands severe bending necessary in some applications and may then be heat-treated for high mechanical properties. At present, tubing raw material is stocked against customer orders. Furnished in commercial size limits from 0.012 to 1.125 in. OD, in walls from 0.002 to 0.035 in., depending on diameter. **Superior Tube Co, Norristown, Penna.**

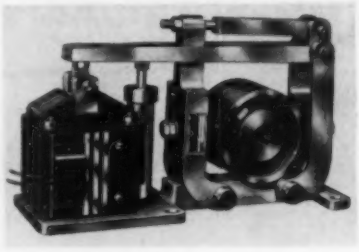
Circle 7, Reader Service Card



Swivel-mounted coupling . . . for hydraulic systems with working pressures to 3000 psi is offered in three configurations and a swivel breakaway frame. Said to seal positively, either connected or disconnected, and to allow full fluid flow with negligible pressure drop. Damage to fluid lines is prevented, because coupling disconnects under min stress. The 5600-couplings, are supplied in ½, ¾ and 1-in. female pipe sizes; 5650-couplings, for connection under pressure, are offered in ½ and ¾-in. female pipe sizes; 5606-couplings, with SAE hydraulic straight thread bosses (O-ring seal), are available in $\frac{5}{16}$ in.-18, ¾ in.-16, $\frac{7}{8}$ in.-14, and $1\frac{1}{16}$ in.-12 thread sizes. Swivel breakaway frame simplifies mounting and alignment of couplings. Couplings can swing 30° in any direction, eliminating side thrust as a source of coupling wear and leakage. Frame is designed with special gimbal for vertical or lateral swiveling action. **Aeroquip Corp, Jackson, Mich.**

Circle 8, Reader Service Card

Solenoid-operated brakes . . . can be converted from spring-set magnetic release to magnetically set spring release in less than 5 min. Line of continuous-duty shoe brakes ranges from 3 ft-lb unit with 2.25 in. dia x 1.5-in. face wheel to 1200 ft-lb unit having 12 in. dia x 6-in. face wheel. Operated by relatively long-stroke solenoids, brakes utilize part of stroke for releasing or setting; other portion as a reserve for lining wear. In this way, time between successive adjustments for wear is extended. Spring characteristics are very flat, permitting large lining wear without alteration in torque setting, and for long periods, without impairing fundamental properties. One screw adjusts lining wear; another adjusts torque setting. Brake shoes, set on spherical socket, permit 15° rotation in all directions, enabling brake to be mounted 15° out of line with shaft without affecting satisfactory operation. Each shoe covers only 75° of drum circumference, allowing 30° additional surface for heat dissipation. Available for ac voltages to 750 v and for all frequencies from $16\frac{2}{3}$ to $67\frac{1}{2}$ cps. Offered for dc shunt connections up to 750 v and for series connections in any value of current and to withstand 750 v to ground. **Trombetta Solenoid Corp, 329 N Milwaukee, Milwaukee 2.**



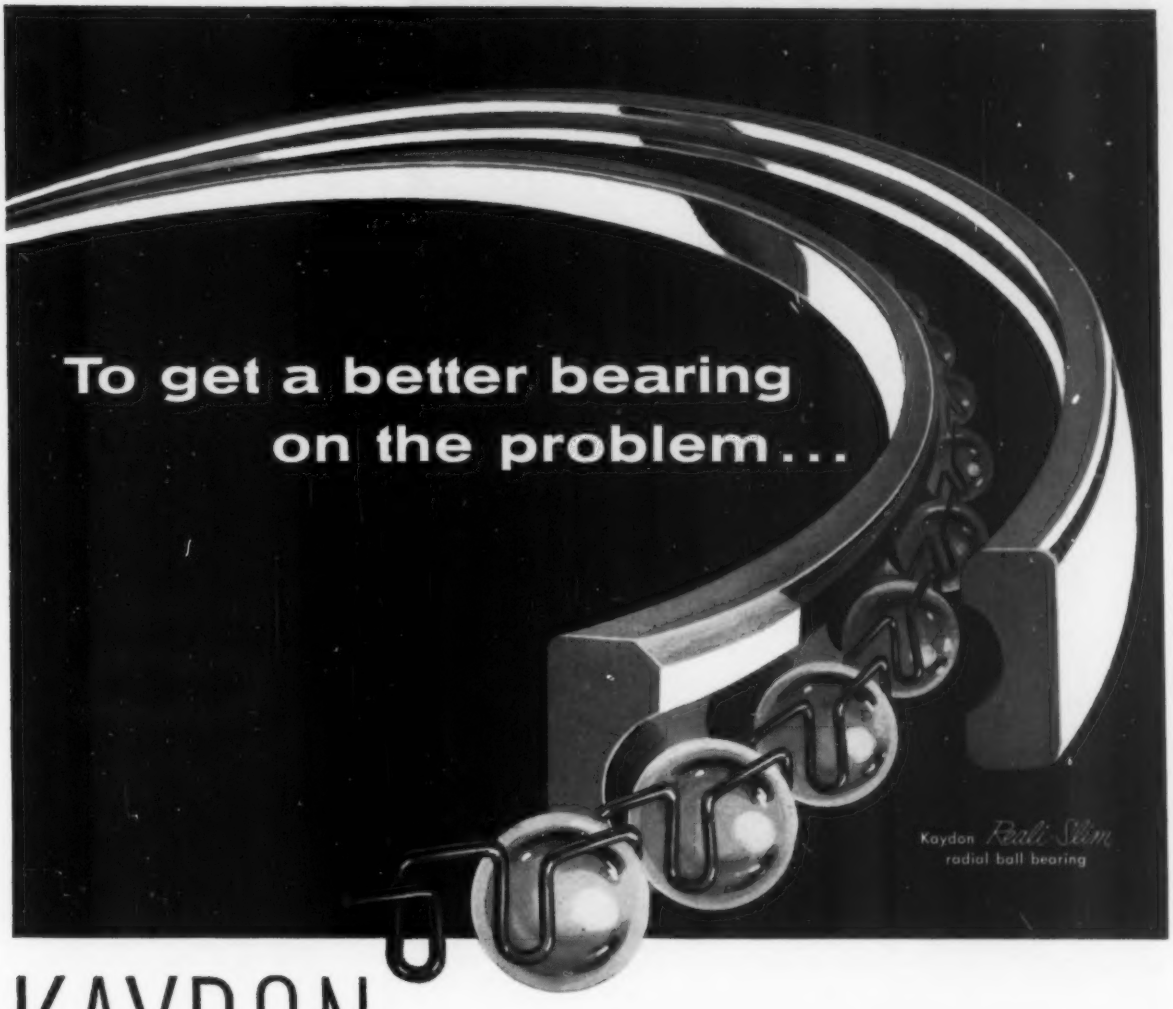
Circle 9, Reader Service Card

Oiltight pressure switch . . . for heavy-duty industrial applications on machine-tool hydraulic systems operates at pressures to 5000 psi. Compact unit has sealed die-cast aluminum enclosure. Also meets NEMA 12 requirements. Calibrated range scale and indicator shows operating pressure, and visible trip indicator shows when contacts operate. Range adjustment, mounted on top of enclosure, changes both operating pressure and reset pressure. Differential adjustment controls reset pressure only and are accessible from front when cover is removed. May be arranged for SPDT operation or separate circuit operation with same polarity. Switches in five ranges up to 500 psi use a bellows; systems up to 5000 psi have piston design. Latter units are made for use with return oil line, where accuracy and low differential are important, or 1000 and 3000-psi switches are equipped with oil seal ring for use where return oil line is not wanted. Piston-type units withstand max surge pressure of 10,000 psi. **Allen-Bradley Co, 136 W Greenfield Ave, Milwaukee 4.**

Circle 10, Reader Service Card

Scanning range is tripled . . . for pickup heads of photoelectric scanning systems by new light source with adjustment to sharply define light spots at any

. . . CONTINUED ON PAGE 110



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Why penalize product-performance success with "make-do" bearings? Kaydon's long experience points out that standard bearings often *won't do*, aren't always efficient or economical. *Kaydon engineers creatively design, develop and manufacture special, modified, and standard ball and roller bearings.* All-new Kaydon "idea bearings" or modified types will help you *prove* your new product designs; *improve* your redesigns. Kaydon can incorporate millionth's-of-an-inch precision, light weight or super-rugged construction to mate the bearing to your application. Send us sketches or scale prints of your bearing problem. *There's no obligation.*

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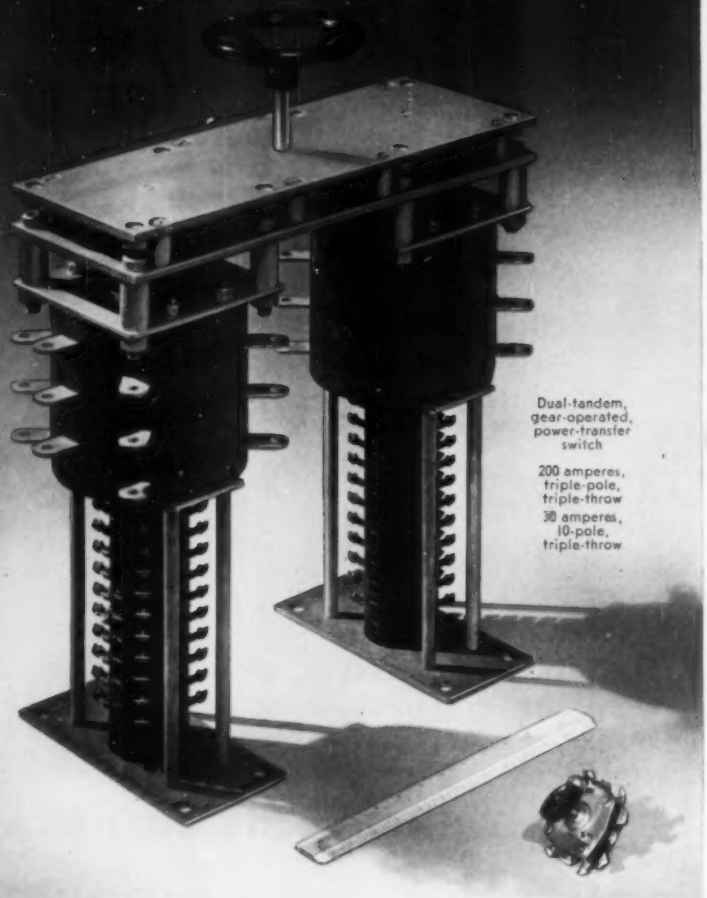


Unusual
or highly specialized
circuit control requirements
can be met by special combinations
of standard ESCO components. This includes
switches to comply with BuShips drawings
and MIL specifications.

Write for Bulletin No. 8

ESCO of WEYMOUTH

ELECTRO SWITCH CORPORATION

167 King Avenue, Weymouth 88, Massachusetts

distance from 12 ft to 5 in. Allows precise control of rapidly moving objects. Working range of system with smaller light source was 1 to 48 in. Medium-range light source is contained in cast-aluminum housing, 1¼ in. sq x 2⅛ in. long. Focusing system extends beyond housing 1⅛ to 2⅛ in., depending on focus. Uses 6.3-v lamp, operated at 4.8 v ac for extended life. Mounting holes are provided in housing or unit can be mounted in 1-in. hole in ¼-in. panel by hex nut as base of focusing tube. **Farmer Electric Products Co Inc, 2300 Washington St, Newton Lower Falls, Mass.**

Circle 11, Reader Service Card

One-component adhesive . . . is smooth, thixotropic paste said not to flow during cure, even when applied to vertical surfaces. Reported to have high strength at 300 F and above. Bonding material is 100% solids and suited for porous and nonporous surfaces. Viscosity is controlled and batch-to-batch uniformity is guaranteed. Adhesive film has slight resiliency that prevents cracking during thermal shock. **Adhesives Div, Houghton Laboratories Inc, Olean, NY.**

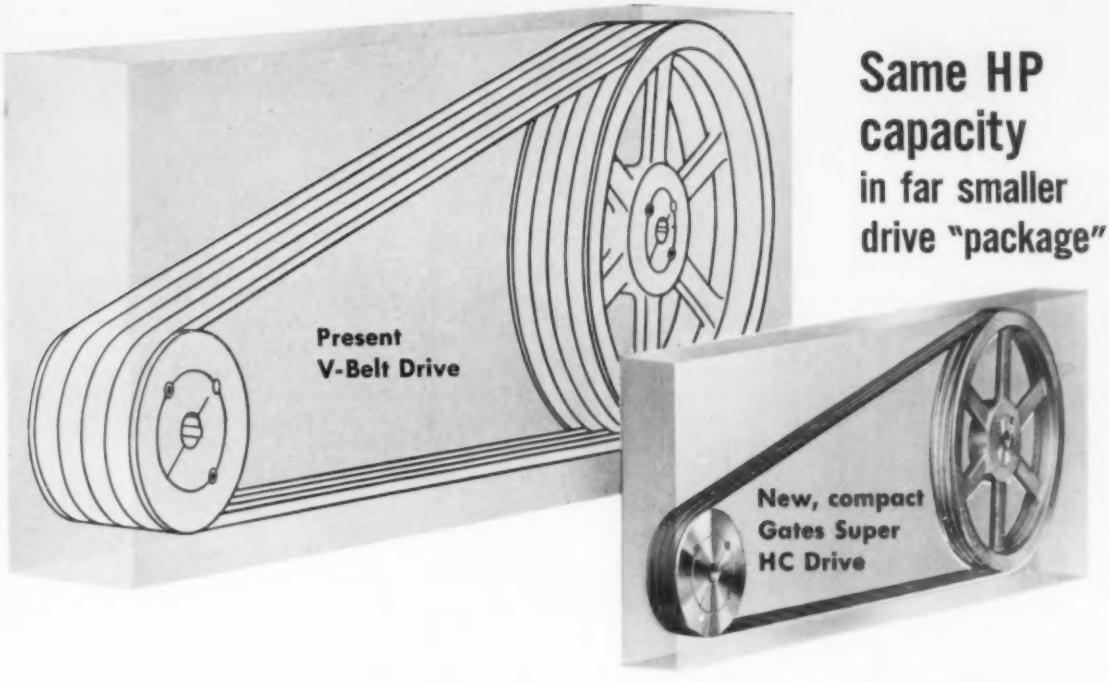
Circle 12, Reader Service Card

Manual pushbutton station . . . is panel-mounted unit for numerical data-input functions. Momentary contact buttons are spaced on ⅞-in. centers to avoid accidental operation of more than one button at a time. Unit can be furnished with various contact combinations per station. Contacts are rated 3 amp, 110 v noninductive. Void button is included. Over-all size is 8 x 3⅞ x 4 in. deep. Requires panel opening 6½ x 3 in. **Carlton Controls Corp, 15 Sagamore Rd, Worcester 5, Mass.**

Circle 13, Reader Service Card

Miniature bearing-shield . . . design is said to reduce size of dirt particles that can get into bearings by as much as 70%. Gap between rings is closed to 0.002 in., or less than one-third that of previous shielding. Close tolerance is made possible by fitting shield to pre-

(Continued on page 112)



Same HP capacity in far smaller drive "package"

New high capacity Gates V-Belt cuts drive space, weight and cost

Reduce size, cut costs! Gates new Super HC V-Belt puts power transmission in a smaller package—cuts costs all along the line!

Actually, this major advance in power transmission—a development of *specialized* research in the world's largest V-belt laboratories at Gates—makes possible the most compact, lightest-weight, lowest-cost multiple V-belt drive you can put on any machine. Sheave diameters can be reduced up to 50%, sheave widths 30% to 50%, center distances 20% and more.

Reduce drive cost as much as 20%

On new drives, the cost of a Gates Super HC V-Belt Drive is as much as 20% under the cost of present V-belt drives of the same hp capacity. Furthermore, smaller housings and bases—less materials, production time, shipping costs all reduce costs still further.

Learn more about the cost-saving Super HC Drive

"The Modern Way to Design Multiple V-Belt Drives" is an informative handbook on the Super HC Drive, available from your nearby Gates Distributor listed in the Yellow Pages under Belts or Belting.

The Super HC V-Belt

transmits same HP in much less space than belts now in use

Shown below are space savings of a typical installation:

	Drive R Sheave Diam.	Drive N Sheave Diam.	Center Distance	No. of Belts
Present Drive	7.4"	20.0"	42.9"	4
Super HC Drive	**5.3"**	**14.0"**	**30.0"**	**3**

TPA 423

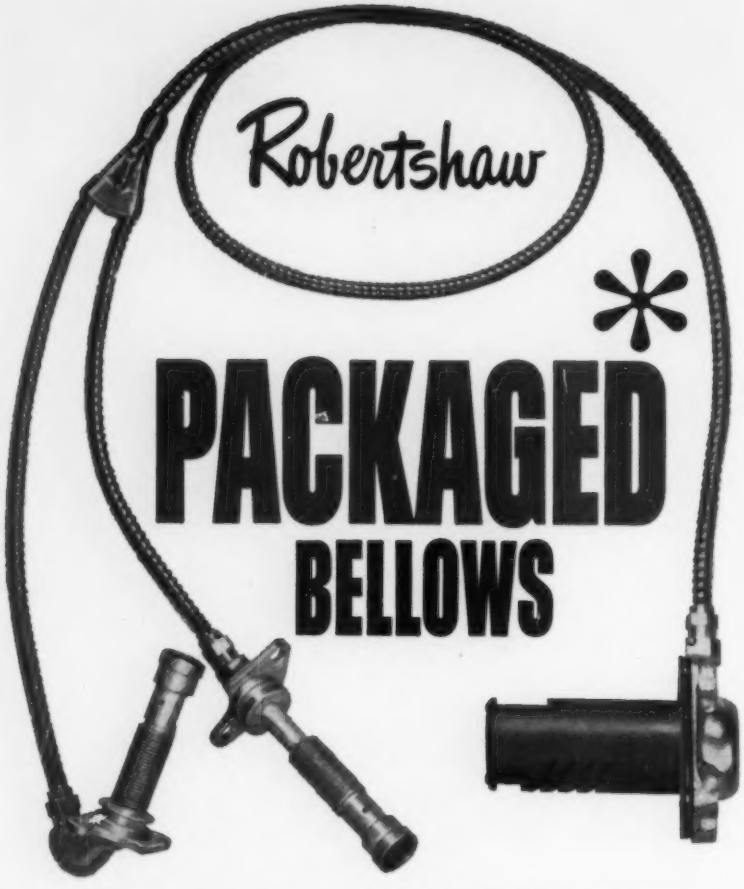
Gates

World's Largest Maker of V-Belts

The Gates Rubber Company • Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates Super HC V-Belt Drives

CIRCLE 145 READER SERVICE CARD 111



...why you save on custom-engineered "one-source" bellows and accessories

* It pays to specify seamless metal bellows *and all assembly components* as one "package"—designed as an integral unit . . . produced to one high standard of quality . . . tested under uniform procedures . . . and delivered already assembled.

Custom-engineered Robertshaw Packaged Bellows save handling, assembling, testing, incoming inspections and paper work in your plant. And you benefit from one source responsibility, no scattered deliveries and lowest possible unit costs.

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Discuss your Packaged Bellows needs with a Robertshaw engineer . . . or get started right now by writing for Bellows Bulletin A-106.

Mr. Controls Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • Milford, Conn.

cision-ground OD of inner rings. Design also leaves no corners where dirt and dust can collect to cause drag between shield and inner ring. Full thickness on side of inner ring provides broader reference surface for mounting. **New Hampshire Ball Bearings Inc, Peterborough, NH.**

Circle 14, Reader Service Card

Self-adhesive foam tape . . .

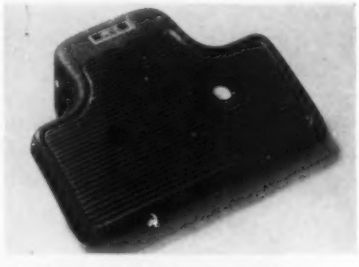
is coated with high-temperature, permanent, pressure-sensitive adhesive that holds bond despite extreme and repeated temperature fluctuations from zero to 300 F. Backed with paper that peels off. Both polyurethane foam and adhesive are reported to be noncorroding and impervious to moisture. Tape insulates for sound and heat, cushions against shock and vibration, seals against dust and dirt, and is chemically inert. Foam, which is flexible, does not compression-set. Tapes are available in a wide range of widths and thicknesses. In large quantities, 32-ft rolls of ¼-in.-thick and ⅜-in.-wide tape are 50¢ each. Samples on request. **Richards, Parents & Murray Inc, 312 7th Ave, New York 1.**

Circle 15, Reader Service Card

High-low level switch . . .

is for use in most liquids. Can be used to actuate warning lights and/or automatic switching mechanisms. Switching line cannot be fouled by fluid contamination and is unaffected by rolling or pitching motions. Time-lag mechanism prevents tripping even when upside down for less than 3 sec. Operates in temperatures of —65 to 250 F on any electrical system from flashlight battery to 300 v at 5 amp. Unit is explosionproof and hermetically sealed. Weighs less than 16 oz. **Divac Div, Acme Machine Works, 13025 Cerise, Hawthorne, Calif.**

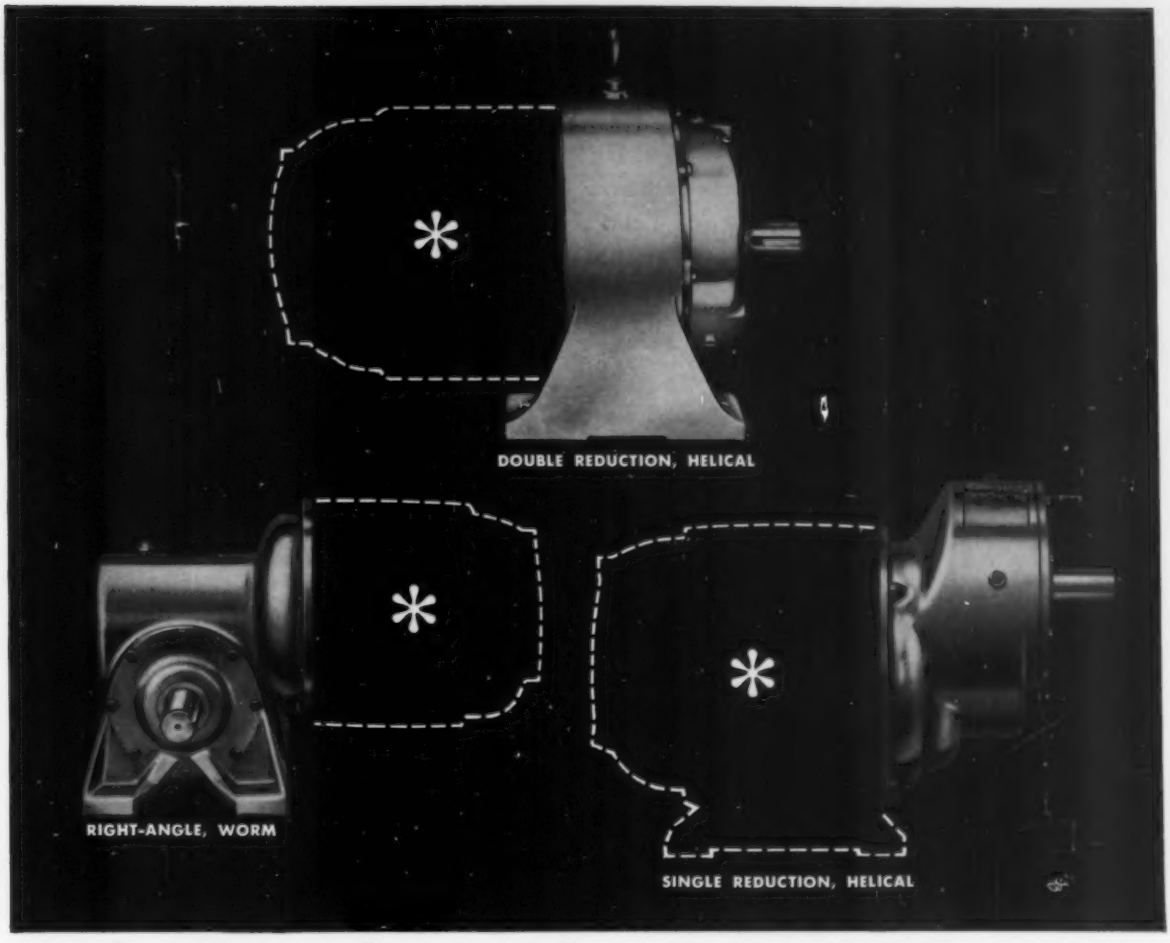
Circle 16, Reader Service Card



Wide-treadle footswitches . . .

for heavy-duty industrial applications are available in momentary and maintained contact types with SPDT or DPDT circuits. Two mounting holes are provided if rigid mounting is desired. Switch has

(Continued on page 116)



Need a Motoreducer with an unusual drive motor?

LET REULAND TAILOR A MOTOREDUCER PACKAGE TO YOUR EXACT NEEDS...

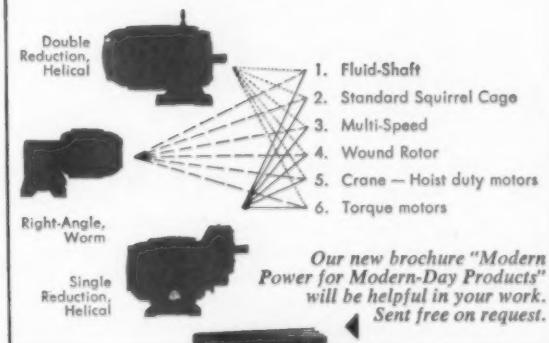
No longer must you "make something do"... no longer must you modify *your* machine to fit the *drive!* Hundreds of different speed and power variations can be developed from the three basic Reuland gear reduction units shown above.

This is made possible through the use of Reuland's famous "Xpandable-Design" idea.

Whether you need a simple motor-and-reducer – or an amazing, automatic combination with a special motor, gear reducer, magnetic brake and fluid coupling – Reuland engineers can quickly solve your drive problem.

Costs are lowered. Development time is saved. Your drive is *right*. Why not see first-hand what a Reuland Motoreducer can do for you.

*** ADD ANY ONE OF THESE 6 DRIVE MOTORS TO ANY OF THE 3 GEAR REDUCTION UNITS SHOWN ABOVE...**



Our new brochure "Modern Power for Modern-Day Products" will be helpful in your work. Sent free on request.

MODERN POWER FOR MODERN-DAY PRODUCTS
. . . ALL IN LIGHTWEIGHT ALUMINUM FRAMES!

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Western Division: Alhambra, California • **Eastern Division:** Howell, Michigan

A DEMONSTRATION UNIT FOR YOUR EQUIPMENT?

So sure are we you'll like what you see, we're offering to engineer a demonstration unit for your equipment without the slightest obligation. Just write us.

CIRCLE 147 READER SERVICE CARD

Mechanical interlocking alone is used to join Dacron,* Orlon* and other synthetic fibers used in new TROYFELT non-woven fabrics. (*DuPont tradenames)

INTRODUCING TROYFELT

a versatile new family of synthetic felts made without chemical binders

Where can you use these amazing new felts? Field-tested and proved for more than two years, these are typical reports:

A FILTER MAKER reports TROYFELT outperforming wool felts 7 to 1 in filtering highly abrasive Taconite ore.

AN ELECTRONICS firm finds TROYFELT a superior packing because it stays resilient at high and low temperatures.

A CUTLERY MAKER uses TROYFELT to polish stainless ware . . . finds its smooth surface gives higher luster, lasts longer.

. . . window makers use it as an impervious life-time seal . . . shoe makers because it lasts longer as a padding . . . gasket makers because it die cuts without ravelling . . . it's also used as wadding in cartridges . . . as a vibration isolator.

WHAT IS TROYFELT?

. . . basically, TROYFELT is a non-woven synthetic felt. It is available in Dacron, in Orlon, and in other synthetics. Unlike other non-wovens it has no chemical binders . . . the individual fibers are joined mechanically. Thus it is a softer material, a better insulator, a better filter, a better packing, padding and wick.

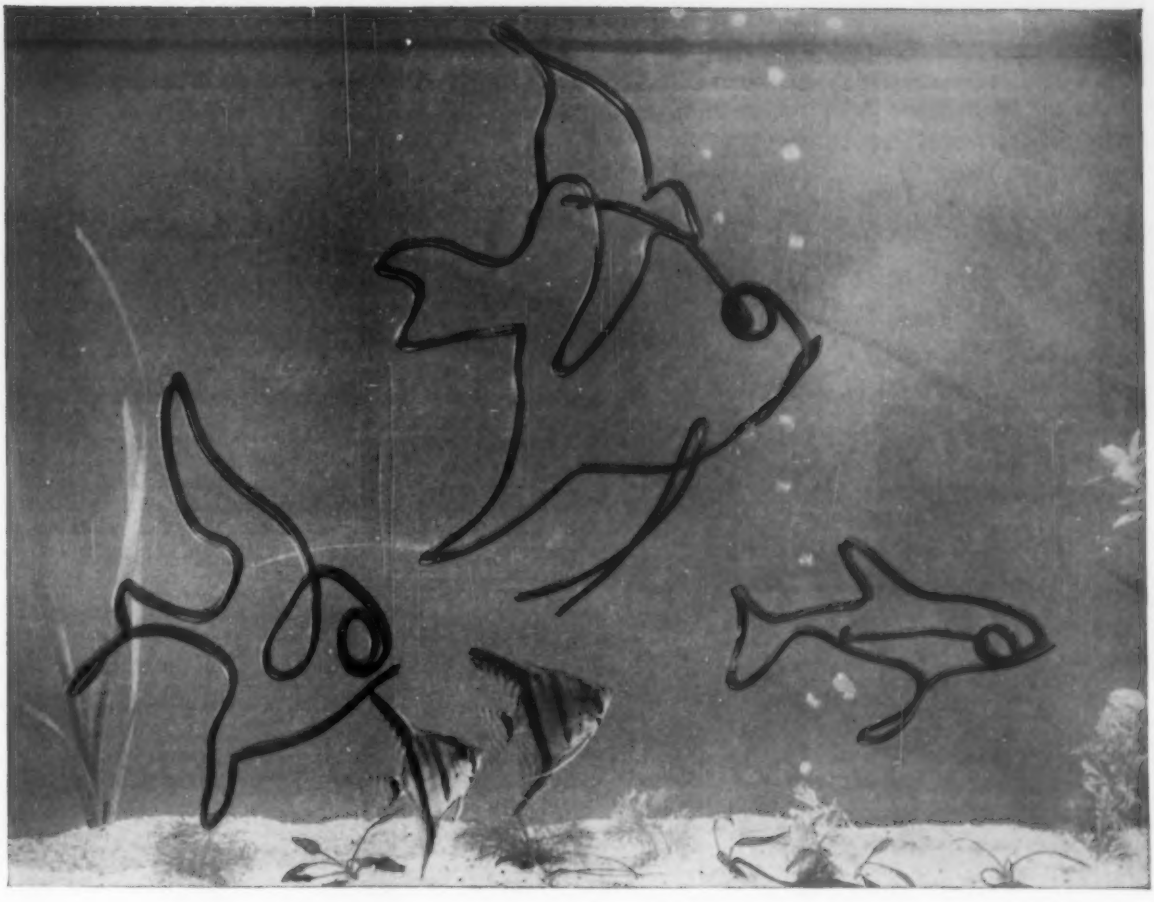
And yet TROYFELT *offers all the long-lived properties of the synthetics: a marked resistance to chemical attack, heat, abrasion and wear!*

Want *all* the facts? Just circle the number below on this magazine's handy reply card.

TROYFELT ... *by the pioneers in non-woven synthetic felts*

INDUSTRIAL PRODUCTS DIVISION • TROY BLANKET MILLS

200 Madison Avenue • New York 16, New York



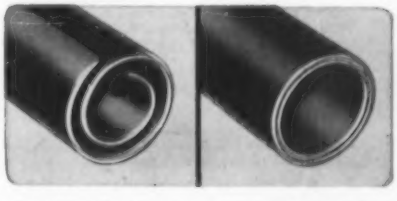
Bundy can mass-fabricate practically anything

. . . and we use Bundyweld®—the double-walled steel tubing—for parts that must meet rigid specifications

YOUR tubing headaches are Bundy's business. Our tubing engineers will work with you at any stage in the development of your product. With years of problem solving experience, we can often suggest short cuts that cut costs of tubing parts—or find practical solutions to tough bends.

Then we'll mass-fabricate these parts on machines specially designed by Bundy for precision bending. We use Bundyweld, the original double-walled steel tubing, that has become the safety standard in small-diameter tubing. It's thinner walled—yet stronger, has high bursting and fatigue strengths.

Why don't *you* take advantage of Bundy's complete service: expert engineering help, mass-fabrication savings, ***Bundyweld*** tubing. For more information see Sweet's Product Design File, le/Bu . . . or contact us!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no real substitute for Bundyweld Tubing

BUNDY® TUBING COMPANY

DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

GENERAL INDUSTRIES

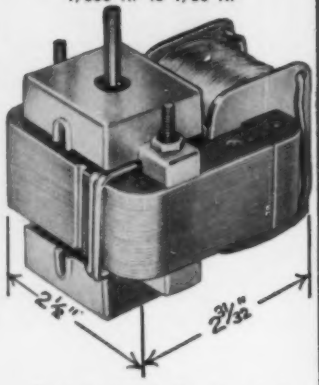
Smooth Power

AC MOTORS

1/1800 H.P. to 1/25 H. P.

2-POLE SHADED-POLE MOTOR

1/550 HP to 1/50 HP



Designed and Constructed with Features That Insure

EXTRA YEARS OF SERVICE

When exceptionally long service is a must, you can rely on GI's new Model H, 2-pole, shaded-pole motor. The Model H is constructed with many outstanding features that assure thousands of EXTRA HOURS of service under the most adverse operating conditions. Available in nine models that cover a wide range of applications.

OIL CAPACITY MANY TIMES GREATER THAN CONVENTIONAL MOTORS Oversized oil bearing reservoirs hold considerably more oil and wicking assuring more efficient lubrication over a longer period of time.

REVOLUTIONARY METHOD OF PACKING THE OIL WICKING A unique new method of packing the oil wicking assures equal oil distribution at all times resulting in quieter operation and longer, trouble free life.

DIE-CAST BEARING BRACKET This new "H" Motor design includes a rugged die-cast bearing bracket that insures permanent precision alignment and adds to the over-all durability.

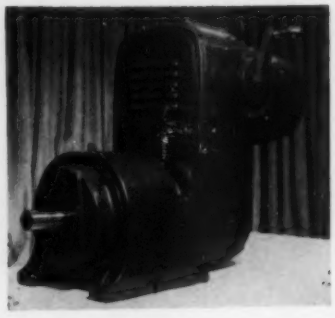
Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

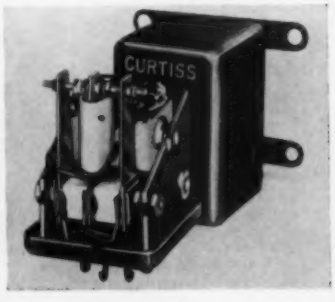
molded nylon actuator and is said to have high electrical ratings. **Linemaster Switch Corp, 432 Woodstock Terrace, Woodstock, Conn.**

Circle 17, Reader Service Card



Mechanical drives . . . are operated by V-belt-connected, adjustable-pitch pulleys. Package design provides internal clearances for belt replacement without sacrificing external dimensions. In addition, controls are said to be undisturbed and belt tensioning to be automatic and immediate. Control design directs actuating force through "equalizer" that prevents binding or sticking of speed-control function. Control location is flexible and can be relocated in the field. Adjustable-speed drives are offered in ¼ through 25-hp ac ratings in output speeds of 5 to over 4000 rpm. Standard speed variations are 2, 3, 4, and 5:1. Available with accessories for remote control and remote speed indication. **General Electric Co, Schenectady 5.**

Circle 18, Reader Service Card



Instant-reset delay relays . . . recycle immediately when de-energized if time delay is the same for each succeeding cycle. Circuit with thermal time-delay relay and magnetic relay utilizes heating and cooling intervals to obtain time-delay periods. When cooling interval is completed, thermal relay is ready for next cycle. Factory-preset time delays between 5 and 180 sec are available. Voltage-compensated from 22 to 32 v dc with nominal 28-v rating. Temperature-com-

(Continued on page 120)

LAMINATED CONTACT MATERIALS

All Contact Materials are Specials!

When you need top quality and fast service, specify Leach & Garner. All mill shapes and types available, including toplay, thrulay, inlay, overlay, edgelay, wire and tubing with alloys of Gold, Silver, Platinum and Palladium. Also available are silver and gold solders, silver and laminated waveguide tubing, precision rerolling and redrawing of non-ferrous metals.

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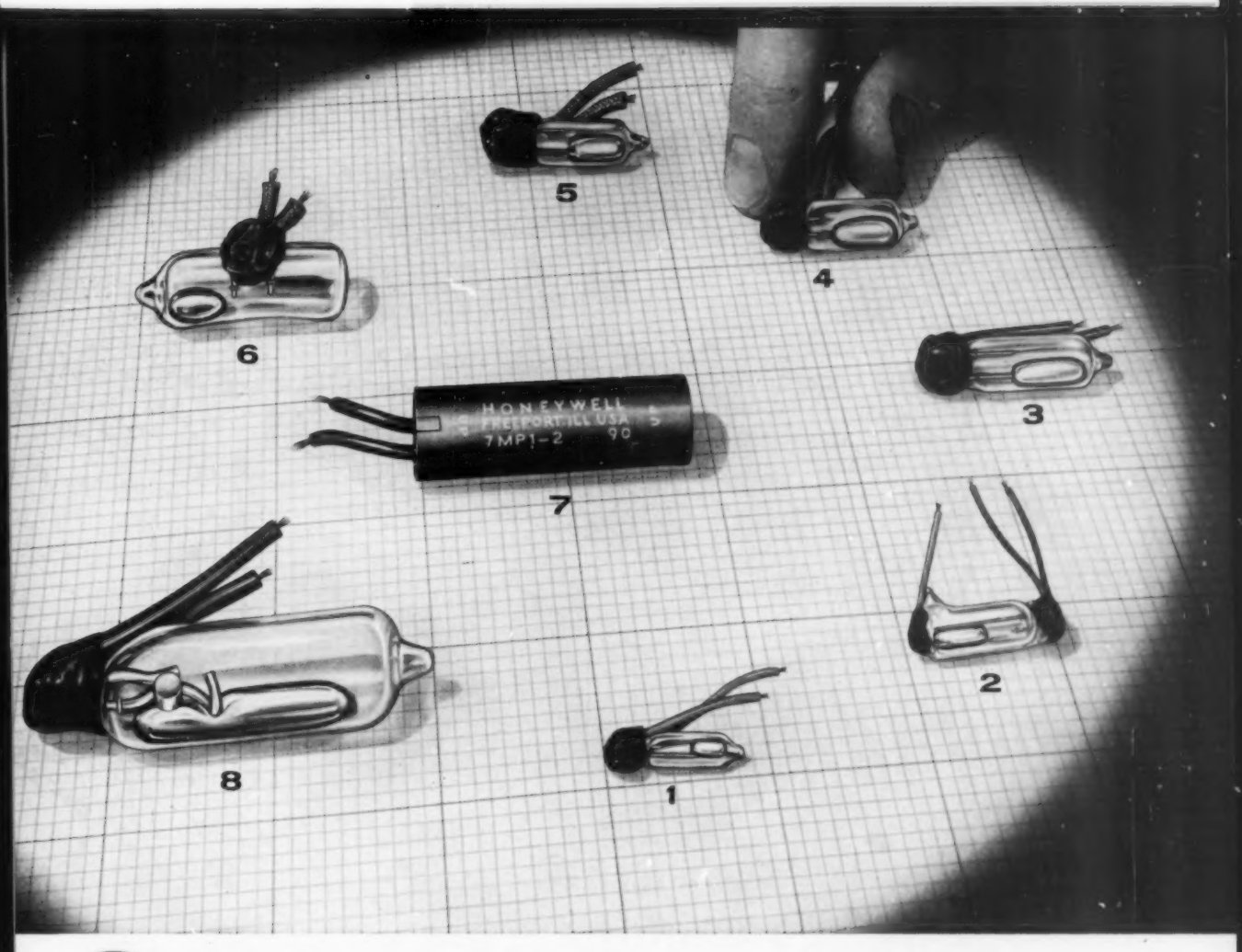

8 widely useful mercury switches now in automatic production

1 AS419A1—Length: 0.90″. Combines smallest available size with long life and reliability. Weight: 0.9 gram (without leads). Tube diameter: 0.174 nominal. SPST.

2 AS603A1—Length: 1.060″. Ultra small, super-sensitive, sealed. The most precise mercury switch available. Weight: 3.5 grams (including leads). SPDT.

3 AS417B2—Length: 1.500″. Offers small size with 3 amps. capacity at 115 vac or vdc.

4 AS408C1—Length: 1.375″. Nominal rating of .25 amp. at 1.5 vac or vdc, also operates in micro-volt and milli-ampere ranges.

5 AS408D1—Length: 1.375″. An economical switch widely used in appliances and vending machines. SPST. Rating: 1 amp., 115 vac or vdc, resistive.

6 AS702B1—Length: 1.625″. Mercury pulse switch has curved glass tube. Used in business machines, counters, timers, etc. SPST.

7 7MP1-2—Length: 1.875″. Embedded in synthetic rubber and enclosed in a nylon can. Resists shock, corrosive fumes, and fungus. Unaffected by oil and water. Operates in temperatures from −35° to +200°F. 3 amps., 115 vac or vdc, resistive. SPST.

8 AS454A34—Length: 2.500″. Medium size. Handles loads up to 10 amps., 115 vac, resistive. Sealed contacts. Low force tilt action. Wide use—machines, tools, appliances, etc.

Each of these Honeywell Mercury Switches is exceptional in terms of its own qualities and characteristics. Just as important, *all* are in fully automatic production at MICRO SWITCH in Freeport.

This means that one of a kind is precisely like another of its kind—same weight, same mass, same external dimensions within a thousandth of an inch. *This* means —as you know—uniformity of performance and uniformity of fit that make life easier for designer and production man. And the savings from automatic production permit minimum price for highest quality.

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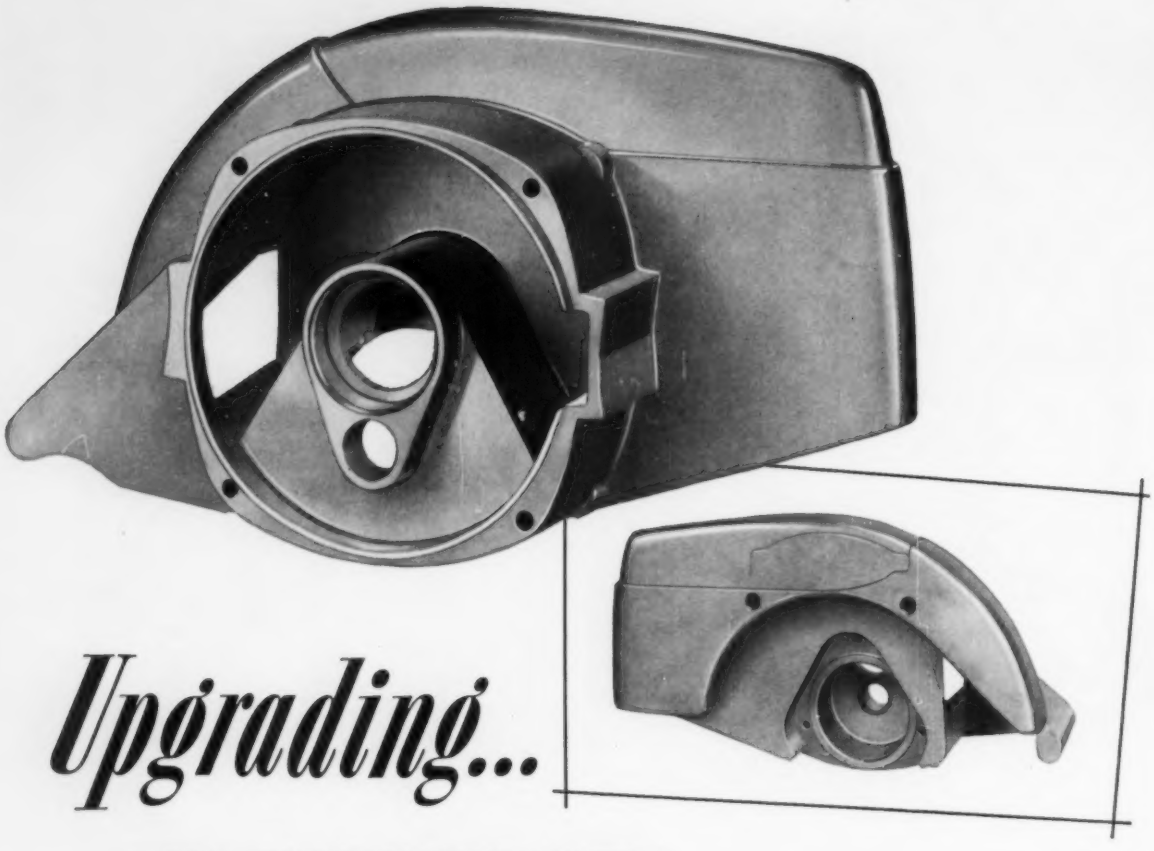
MICRO SWITCH Precision Switches

CIRCLE 152 READER SERVICE CARD



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CHECK THESE 10 POINTS OF T-J SUPERIORITY

1 One Piece Piston

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6 Solid Steel Heads and Mounting Plates Standard all Models

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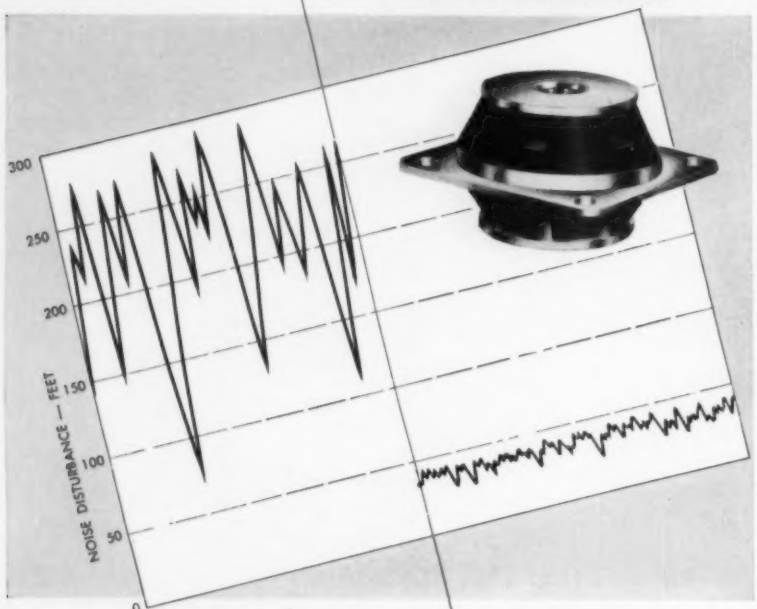
9 Piloted Packing Gland–Absolute Alignment

10 Piston Rod, Extra Strong–Polished and Chrome Plated for Efficiency and Protection

T-J TOMKINS-JOHNSON

YOUR DESIGNS SELL BETTER when shock and vibration are reduced



BEFORE

Operating noise from a solidly mounted magnetic switch could be heard 250 feet away.

AFTER

With the same switch on Barry-mount isolators, noise is unobjectionable at only 35 feet.

Whatever *your* shock or vibration problem may be, Barry's skilled specialists will give it individual attention.

And you can *demonstrate* results in an *improved competitive position* for your products.

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Technical bulletins that will help you solve vibration and noise problems are free on request.

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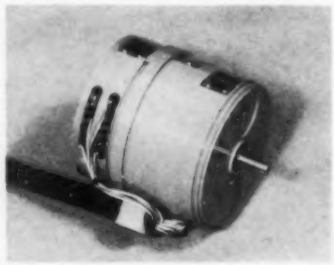
CIRCLE 155 READER SERVICE CARD

pensated for −85 to 257 F. Operates under vibration to 500 cps to 15 g and withstands shock of 50 g for 11 millisec. Operates on 10 w during timing; less than 3 w after timing interval. Various contact arrangements are offered, rated at 2 amp, 28 v dc resistive. Approximate over-all size is $1\frac{5}{8}$ x $1\frac{3}{16}$ x $1\frac{1}{2}$ in. for units to 90 sec; slightly larger for longer time delays. **Curtiss-Wright Corp, Electronics Div, Components Dept, 620 Passaic Ave, W Caldwell, NJ.**

Circle 19, Reader Service Card



Lightweight encoder . . . assembly uses two encoders and a gearbox to resolve shaft positions to 1 part in 36,000. Designed for use where min size (3 in. dia. x 3 in. long) and weight (19 oz) are important. Encoder used on input shaft provides 1000 positions of least significant digit per 360° rotation. Because encoder disk is coupled directly to input shaft, accuracy is said to be that of encoder used, ± 1 count. Input unit is then geared 36:1 to 36-position encoder. Low-speed encoder utilizes double-brush, lead-lag logic to eliminate ambiguities due to gear inaccuracy and backlash. Assemblies with higher number of positions are also available. **Datex Corp, 1307 S Myrtle Ave, Monrovia, Calif.**

Circle 20, Reader Service Card

Nonstaining adhesive tape . . . in black for photographic and drafting work are offered in precision tolerance widths from $\frac{1}{64}$-in. up to any fraction of an inch in 15- and 60-yd rolls. Narrow precision-cut tapes are backed with clear, pressure-sensitive adhesive. Tape is also available in rolls 3 in. wide and 5 yd long. Samples on request. **By-Buk Co, 4314 W Pico Blvd, Los Angeles 19.**

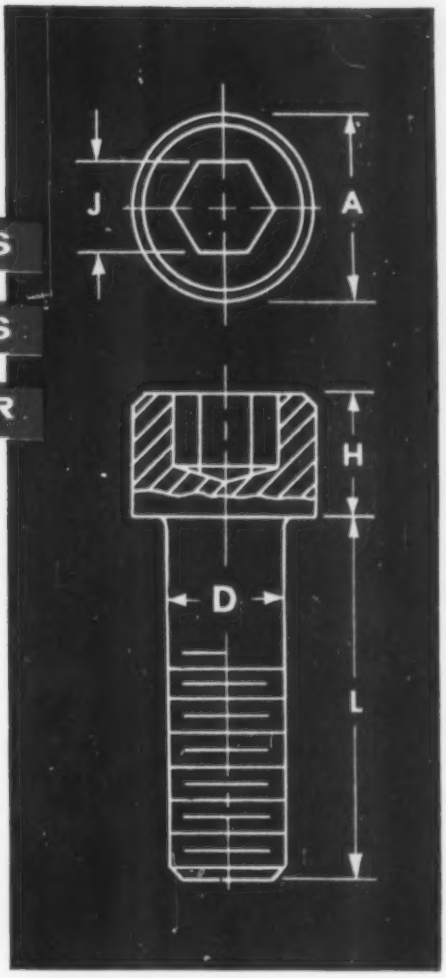
Circle 21, Reader Service Card

Thermal time delay . . . offers resistance to vibration of 20 g up to 2000 cps and to shock of 50 g for 11 millisec. There is no resonance below 2000 cps. Operating-time delays of 3 to 60 sec are available. Time delay is factory-

(Continued on page 122)

DESIGN ENGINEERS:

NEW ENGINEERING STANDARDS MAKE SOCKET CAP SCREWS AN EVEN BETTER FASTENER



HOLO-KROME ANNOUNCES THE NEW "1960 SERIES" FORGED SOCKET HEAD CAP SCREWS

Design engineers can now take a *fresh* approach to today's fastening problems as a result of new, *engineered* socket cap screw standards recently developed by engineers of the socket screw industry.

Two major advantages of the change—

INCREASED BEARING SURFACE

Head diameters were increased in certain sizes—5/16", 7/16", 5/8", 3/4", 7/8", 1"—and the bearing surface under the head is larger. Designers can now take this increased bearing surface into account and obtain even better fastening from H-K Socket Screws.

LARGER SOCKETS, HIGHER TORQUE

Larger sockets in certain sizes—carefully selected after extensive testing—permit cap screws to be torqued to the maximum and allow designers to take full advantage of the tensile strength of H-K Socket Cap Screws.

Start *right now* to incorporate these new socket cap screw standards in your current design project.

SOLD ONLY THROUGH AUTHORIZED DISTRIBUTORS

FREE BROCHURE LISTS NEW DIMENSIONS

Write for a brochure setting down complete details on the new "1960 Series" socket cap screw standards.

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helped create higher rated, longer lasting switch
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"Impossible", yes by any other method. BUT—GRC's unique single cavity die casting techniques made possible a detailed and complex actuating mechanism with exceptional requirements of uniformity and accuracy. Inspired Mallory engineers to design a new and better switch around this GRC die cast mechanism! Just another instance in which GRC's exclusive patented methods have solved a parts problem and opened the door to a new product . . . at substantial savings.
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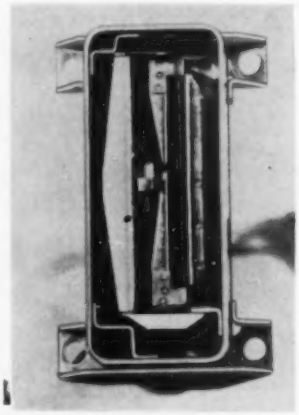

set within tolerance of 5% and hermetically sealed in rectangular case, $1\frac{9}{16}$ x $2\frac{1}{4}$ x $\frac{3}{4}$ in. high. Effects of ambient temperature are held to 5% over range of —85 to 257 F. Heater voltages range from 2 to 115 v for delays of 3 to 12 sec and from 2 to 230 v for longer delays. SPST contacts, normally open or closed, are rated 2 amp resistive at 115 v ac or 28 v dc. Dielectric strength is 1000 v at sea level; 500 v at 70,000 ft. Encased relays weigh 2 to $2\frac{1}{4}$ oz. **G-V Controls Inc, Okner Parkway, Livingston, NJ.**

Circle 22, Reader Service Card

Selective plating matrix . . .

permits several isolated circuits to be carried from one side of a board to the other side through a common plated-through hole. Using this technique, alternate areas of hole wall are plated and separated from each other by nonplated, insulating areas. Insertion of any conducting pin into a hole will close circuit between conductors. Applicable to printed circuits and to holes included as part of circuitry of printed circuit board. In the latter use, introduction or withdrawal of a conducting pin provides single-pole switch action. **Allied Sales Co, 20 Main St, Belleville, NJ.**

Circle 23, Reader Service Card

Slide chart tells cost . . .

of plating precious metals per unit area to specified thicknesses. By setting device to price paid per troy oz or gm, plating cost of various formulations can be read directly. Copyrighted chart tells cathode efficiency date; mgm per sq in. and gm per sq ft of particular precious metals for 0.0001-in. deposits; recommended current densities and actual plating time; corresponding thicknesses, in millionths of an inch, of 1 mgm per sq in. and 1 gm per sq ft for various precious metals. Logarithmic progression scale found on con-

(Continued on page 125)

Modern Variable Speed Fresh new look and improved performance to a time-tested and proved product. Reeves Vari-Speed Motodrives are now available in this smart design . . . ¼ thru 20 hp. . . . 2:1 thru 10:1 speed variation . . . 1.8 thru 4660 rpm. A compact power package for infinitely variable output speeds designed and engineered to meet virtually every production need. Hundreds of space-saving standard assemblies: output shaft on same side or opposite side of motor; vertical, 45°, horizontal and trunnion models; no reducer, and single, double, or triple stage reductions. Full range of modifications, accessories, and manual, remote, or automatic controls.

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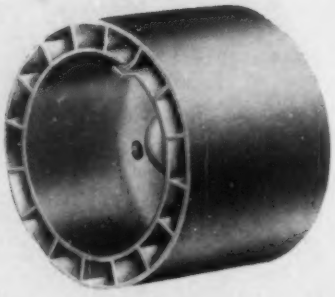

magnesium

cobalt alloy

stainless steel

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ventional slide rules were integrated with specific gravity measurements to provide data available on these scales. Price, $1, postpaid. **Sel-Rex Corp, 75 River Rd, Nutley 10, NJ.**

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Circle 25, Reader Service Card

Preprinted paper . . . includes recurring technical details, basic standards. Optional items are preprinted in lines that disappear when blueprinted—or may be pencilled or inked over to reproduce. Nonreproducing lines are printed on reverse side. **Clearpoint Paper Co, 1482 67th St, Emeryville, Calif.**

Circle 26, Reader Service Card

Packaged lighting device . . . used in fixed relationship to a camera lens, is said to eliminate variables in illumination of technical subjects. Model VI, particularly designed for lighting of engineering-department material and such subjects as mechanical and electronic gear, has central aperture through which optical system of a photographic or TV camera operates. Unit is essentially an exponentially graded, high-intensity, cold-cathode fluorescent tube permanently mounted in a special reflector. Subassembly is enclosed in housing with adjustable, reflective wings. Mounting and attaching accessories are available for back focusing or 35mm equipment. Assembly consists of light package, transformer that operates on standard 115-v, 60 cps current, interconnecting cable, adapter and transit case. **Hinelight Corp, 2538 John St, Ft Wayne, Ind.**

Circle 27, Reader Service Card

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Your design is *new* — not a collection of stock items. Nor can your critical requirements be met by stock bellows.

Your bellows function is dependent on endless variables of temperature, pressure, atmosphere, stress.

The correct bellows assembly must be specifically designed for the job — and Robertshaw engineers are at your elbow with more *bellows answers* than anyone else!

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NEW BOOKLET! *For technical data on Sylphon® Bellows — and cost-saving Bellows Assemblies — write for just-issued catalog LPR*

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FULTON SYLPHON DIVISION • Knoxville 1, Tennessee

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 130.

PRODUCERS OF IRON-NICKEL ALLOYS—1959 Directory, 16 pp. Compilation of manufacturers, compositions and identification of forms produced, from information provided by the manufacturer. Includes index of trade names. Reader Service Section, International Nickel Co Inc, 67 Wall St, New York 5.

Circle 28, Reader Service Card

FLEXIBLE RULER—12-in. ruler for measuring curved surfaces and irregular areas has ½-in. gripping areas at both ends. Designed to demonstrate versatility of metal-like plastic moldings. Available free. Anchor Plastics Co Inc, 36-36 36th St, Long Island City 6, N. Y.

Circle 29, Reader Service Card

PRINTED-CIRCUIT CONNECTORS—Catalog, 24 pp. Describes variety of connectors that accommodate ⅛, 3/16 or ¼ in. printed circuit cards. Covers specifications, outline dimensions, general information and suggested applications. Electronic Sales Div, DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1.

Circle 30, Reader Service Card

CASTERS—Catalog 159, 24 pp. Contains descriptions, specifications, illustrations and cutaway views of swivel-plate and rigid-plate truck casters with load capacities of 100 to 15,000 lb each. Also information on spring-action, V-grooved, grease-sealed, scaffold and furniture casters, floor truck locks and industrial wheels. Faultless Caster Corp, Dept PR-74, Evansville 7, Ind.

Circle 31, Reader Service Card

STOCK METAL-STAMPINGS—Catalog 22, 58 pp. Hundreds of standard metal stampings and wire forms are illustrated in sketches and plan drawings. Small metal parts are hot tinned. Company also manufactures special parts. Zierick Mfg Corp, 110 Beechwood Ave, New Rochelle, N. Y.

Circle 32, Reader Service Card

INTERNAL GEAR ROTARY PUMPS—Set of 4 folders, 4 pp each and 2 catalog sheets, 2 pp each. Folders are color-coded for one specific standard pump series, A through D. Each contains descriptions, construction details, specifications, ordering instructions, assembly data, and dimensions for pump, V-belt and gear-driven assemblies. 2-pp monographs describe steam-jacketed Series E and Series C and D units in 200 and 300 gpm capacities. Wayne Pump Co, Griffin St, Ft Wayne, Ind.

Circle 33, Reader Service Card

LIGHTWEIGHT SELF-LOCKING NUTS—Brochure, 24 pp. Includes popular styles and sizes of lightweight, low-height, self-locking, all-metal nuts. Contains specifications, mounting styles, materials, finishes and dimensional drawings. Nutt-Shel Co, 2701 S Harbor Blvd, Santa Ana, Calif.

Circle 34, Reader Service Card

MINIATURE ELECTRICAL CONNECTOR—DS catalog, 8 pp. Brief description of design data and detailed instruction on contact crimping, insertion and removal. Exploded cutaway view and dimensional drawings are included. Deutsch Co, 7000 Avalon Blvd, Los Angeles 3.

Circle 35, Reader Service Card

HAND-LEVER SERVO CONTROL—Bulletin 36301, 4 pp. Description, specifications and features of manual and preset controls for one or more electro-hydraulic servovalves. With dimensional drawings and photo views. Servocontrol, Div of Oilgear Co, Milwaukee 4.

Circle 36, Reader Service Card

GENERAL-PURPOSE AND HIGH-STRENGTH LATCHES—Brochure, 30 pp. Dimensional drawings of latches, each composed of two basic components. Unique format permits tracing of housings from one set of pages and suitable fittings from a matching set of pages. Acts as drawing aid. Simmonds Aerocessories Inc, 105 White Plains Rd, Tarrytown, NY.

Circle 37, Reader Service Card

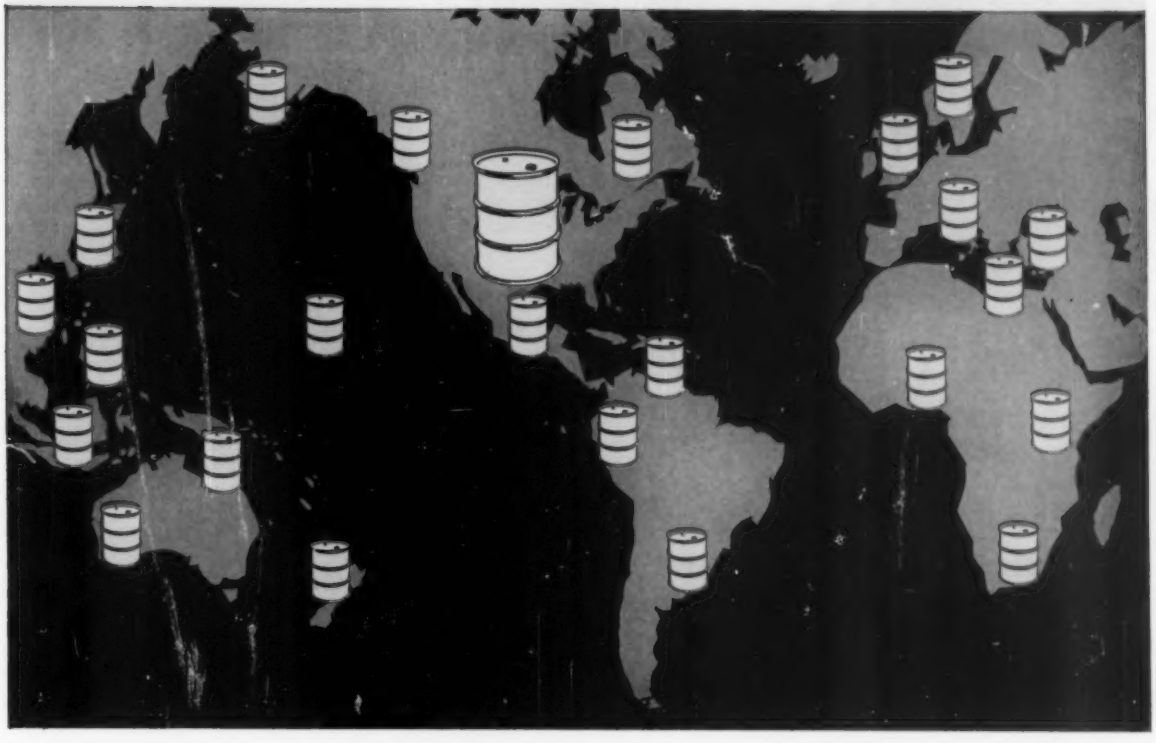
MERCURY SWITCHES—Catalog 90b, 12 pp. Describes standard line of mercury switches. Covers dimensions, electrical ratings, specifications and application information. With photos and drawings. Micro Switch, Freeport, Ill.

Circle 38, Reader Service Card

STOCK STAINLESS-STEEL FASTENINGS—Catalog 59-A, 24 pp. Specifications, descriptions and drawings of over 7000

(Continued on page 128)

Wherever your customers buy MACOMA...



Its performance and name are the same around the world

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oils—for hydraulic systems

Shell Alvania Grease—multi-purpose industrial grease

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils—soluble cutting oils for high-production metalworking

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Shell Macoma Oils are available world-wide . . . assurance that your customers abroad will get the same performance from your equipment that your domestic customers rely upon.

Macoma® Oils are premium quality, fortified extreme pressure industrial gear oils. They provide superior high-load-carrying capacity and are particularly effective where overloading, severe shock-loading or general heavy-duty conditions exist.

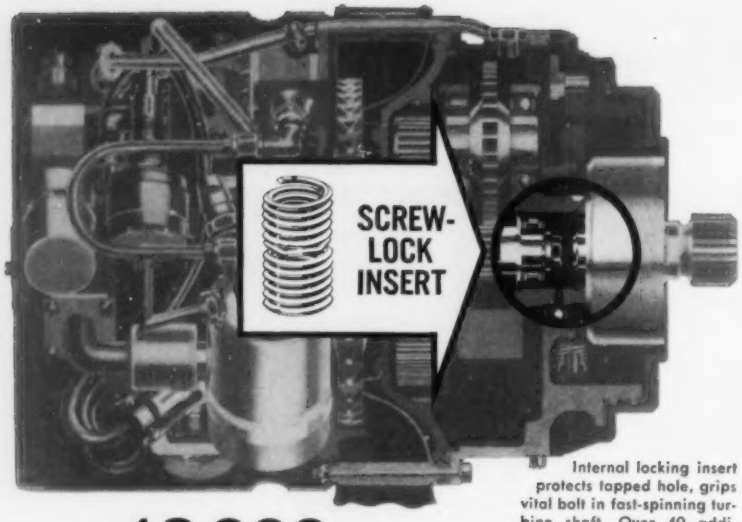
Macoma Oils have these added built-in benefits: excellent resistance to oxidation, great adhesiveness, rapid separation from water. They are non-corrosive, non-foaming and have high stability in storage.

For more information, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California. In Canada: Shell Oil Company of Canada, Limited, 505 University Avenue, Toronto 2, Ontario.

SHELL MACOMA OIL

the extreme pressure industrial gear lubricant

SHELL



Internal locking insert protects tapped hole, grips vital bolt in fast-spinning turbine shaft. Over 40 additional *Heli-Coil* Inserts insure threaded fastener security throughout the starter.

at 46,000 R.P.M.

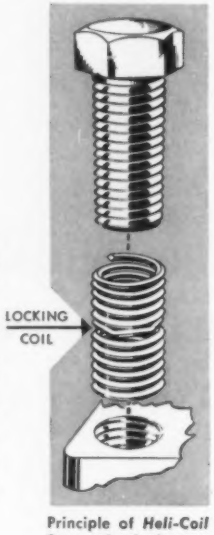
HELI-COIL®

SCREW-LOCK INSERT*

holds this vital bolt fast
...Without Lock Washers
or Lock Wiring!

Even when the turbine shaft of General Electric's new AS-18 turbostarter whirls at 46,000 rpm... the key bolt at the end of the shaft can't work or wear loose. General Electric puts a one-piece, *internal locking* ***Heli-Coil*** Screw-Lock Insert in this tapped hole, gets thread security in this important threaded assembly despite vibration met at high shaft speeds.

In addition to the critical shaft application, General Electric uses more than 40 of these ***Heli-Coil*** stainless steel wire inserts throughout this compact 165 hp starter for aircraft gas turbines. Production and performance benefits? Unshakeable fastener security *without* the use of clumsy, heavy lock nuts, lock washers and lock wiring... lighter weight... less installation cost... faster and easier assembly and disassembly of this tiny power pack that weighs only 46 pounds! *Patented



Principle of ***Heli-Coil*** Screw-Lock Insert. Locking center coil grips screw in tapped hole; holds screw firmly against vibration and impact.

Heli-Coil **Screw-Lock Inserts**

- positively lock screws and bolts against loosening under impact and vibration
- prevent thread wear, stripping, corrosion, galling and seizing
- eliminate lock nuts, lock wiring, other supplementary locking devices
- can be used in standard proportion bosses without need for redesign
- are available in a complete range of U.N.C. and U.N.F. thread sizes
- save assembly time, space, weight and cost
- meet military specs for locking torque and vibration

HELI-COIL CORPORATION
DANBURY, CONNECTICUT

HELI-COIL CORPORATION, **606** ***Shelter Rock Lane, Danbury, Connecticut***
Send complete design data on *Heli-Coil* Screw-Lock Inserts
NAME_____ TITLE_____
FIRM_____
ADDRESS_____
CITY_____ ZONE____ STATE____ 1772

IN CANADA: W. R. WATKINS CO., Ltd., 41 Kipling Ave., S., Toronto 18, Ont.

Catalogs and Bulletins.....continued

items and sizes. Star Stainless Screw Co, 699 Union Blvd, Paterson 2, NJ.

Circle 39, Reader Service Card

MINIATURE ELECTRIC EYE—Bulletin 577, 6 pp. Covers developments in design and application of miniature electric eyes. Compares color range of human eye and electric eye. Photomation Inc, 96 S Washington Ave, Bergenfield, NJ.

Circle 40, Reader Service Card

KNOBS, WHEELS AND HANDLES—Folder, 4 pp. Contains dimensions on line of knobs, levers, wheels, handles and crank handles in tabular form. Machine Products Corp, 6771 E McNichols Rd, Detroit 12.

Circle 41, Reader Service Card

FINE-BLOWN FIBERGLASS INSULATION—Bulletin, 6 pp. General description, physical properties, thermal and acoustical properties, handling characteristics are covered. Includes facings and coatings available, principal uses and available forms. Gustin-Bacon Mfg Co, 210 W 10th, Kansas City 6, Mo.

Circle 42, Reader Service Card

METAL FABRICATING—Brochure, 8 pp. Discusses fabricating and laboratory techniques. Illustrates facilities available for manufacturing or experimental research. Johnson & Funk Metallurgical Corp, Dept A, W Kemrow Ave, Wooster, Ohio.

Circle 43, Reader Service Card

HEAVY-DUTY AIR MOTORS—Bulletin 76-B, 4 pp. Describes 12 models for 11½ to 20 hp. With specifications. Joy Mfg Co, Oliver Bldg, Pittsburgh 22.

Circle 44, Reader Service Card

INDUSTRIAL THERMISTOR THERMOMETERS—Bulletin B, 2 pp. Lists temperature ranges for various models, specifications for standard thermometers and applications. Atkins Technical Inc, 1276 W 3rd St, Cleveland 13.

Circle 45, Reader Service Card

INERTIA AND IMPACT SWITCHES—Brochure, 4 pp. Operating principle, application, general description and characteristics of inertia and impact switches with one moving part. Switches are said to be sensitive to acceleration axially, radially or omnidirectionally from 0.01 to 500 g. Includes tabular listing of standard models. Inertia Switch Div, Safe Lighting Inc, 311 W 43rd St, New York 36.

Circle 46, Reader Service Card

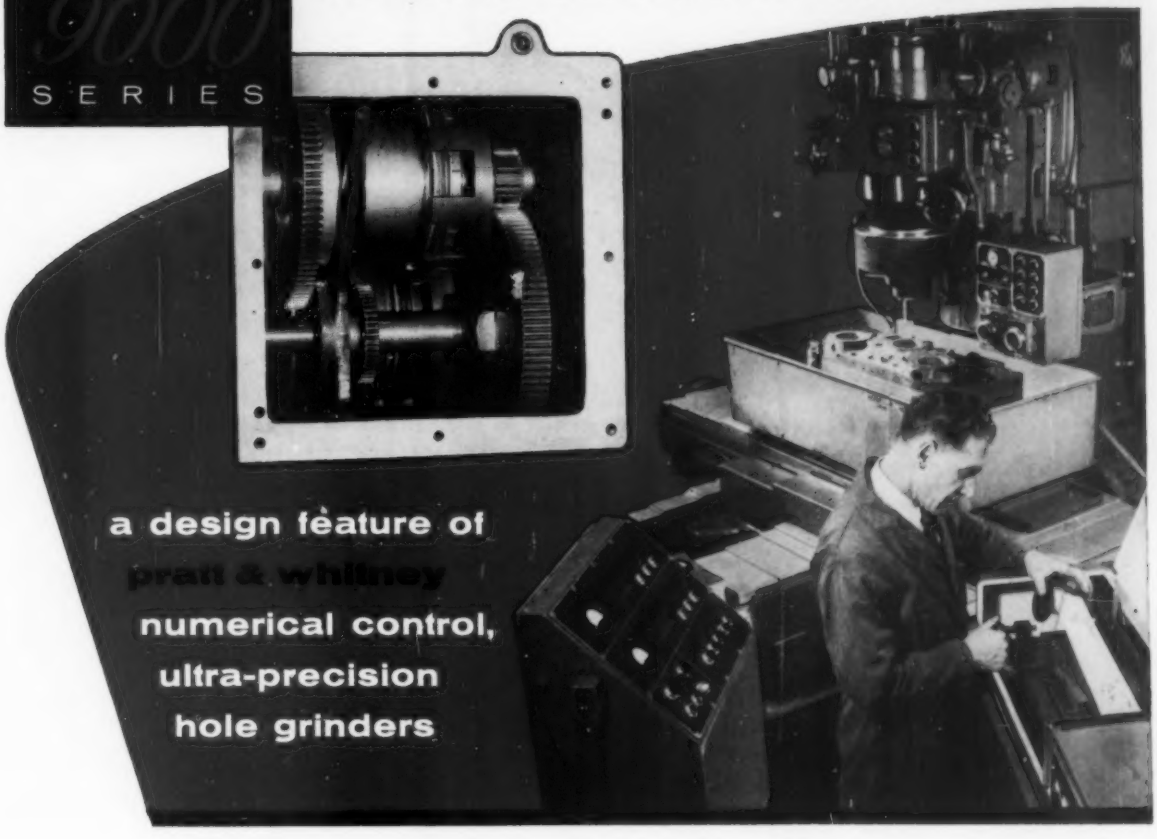
FREQUENCY SENSORS—Bulletin 400 FS, 1 pp. Includes design information,

(Continued on page 130)

new Maxitorq

electric clutches and brakes

9000 SERIES



a design feature of pratt & whitney numerical control, ultra-precision hole grinders

Again a famous machine tool builder favors today's outstanding electric clutches and brakes

Previously, Pratt & Whitney incorporated MAXITORQ Clutches in their high-precision jig borers. Proved performance led their engineers to test and accept the new 9000 series MAXITORQ Electric Clutches for their latest development . . . the fully automatic, numerically controlled, ultra-precision Vertical Hole Grinder and Electrolimit Jig Borers. Inset photograph above shows the compact and "clean" installation of two of these clutches in the carriage control drive gear box.

Incorporating new and advanced design principles, the 9000 Series MAXITORQ Electric Clutch is well adapted to machine tool drives. It is simple in design . . . built to machine tool standards . . . requires no adjustments. It can be used *either as a clutch or brake*. Disc separators not only separate discs but also break up residual magnetism, and result in extremely fast, positive action with no drag or heating in neutral. Design principles have been PROVED through years of service. There are few moving parts. Electrical operating unit remains stationary—hence, there are no troublesome slip rings or brushes; no difficult wiring problems. Clutches operate on standard 110 V a.c. converted to 90 V d.c. Other voltages on special order.

If you have a clutch or brake application where you are looking for NEW and IMPROVED performance, we invite you to bring the problem to us.

Phone, wire or write Dept. PE-12 for new #9000 Series bulletin

The Carlyle Johnson Machine Company, Manchester, Conn.

This revolutionary Carter Rotary Torque Actuator gives engineers a whole NEW field of design opportunities! Up to 370° of rotary fluid power as standard... Safe, powerful torque from air, oil, gas or water power. Zero leakage! Built in cushions! Infinite positioning flexibility! Thousands of applications!

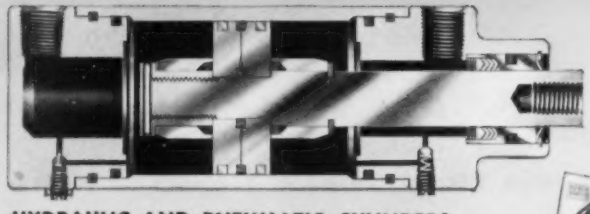
ROTARY

TORQUE ACTUATOR
0-100°
0-190°
0-280°
0-370°
as standard
PNEUMATIC or HYDRAULIC

Patents Pending

Send for 12-page Bulletin with complete engineering data.

CARTER offers unlimited cost-cutting design opportunities through industry's only COMPLETE LINE of LINEAR and ROTARY fluid power actuators!



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1. Space saving designs! Light weight!
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3. Precision honed heavy wall tubing—6 to 1 safety factor.
4. Spring loaded "V" packing on rod end gland.
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Phone: BAyport 1-7186 (Chicago) • GRanite 4-3305 (Lansing, Ill.)

Catalogs and Bulletins.....continued

drawings, specs. Magnetic Circuit Elements Inc, 3722 Park Pl, Montrose, Calif.
Circle 47, Reader Service Card

ROLLERS BEARING BUSHINGS – Brochure, 6 pp. Describes design of live roller bearing bushings and applications. Includes sketches and specs. Donley Products, 11106 Avon Ave, Cleveland 5.
Circle 48, Reader Service Card

PHOTORECTIFIER PLATE – Catalog sheet, 2 pp. Construction and characteristics of photorectifiers. Rex Corp, West Acton, Mass.
Circle 49, Reader Service Card

Letterhead Requests Only

Manufacturers who published following literature ask that requests for copies be made on company letterheads.

THE JETS PROGRAM—Booklet, 16 pp. Discusses organization, program, chapter operation, and sponsorship of the project, which serves to encourage science and engineering programs in local high schools. Also tells how to initiate the program. Jets Inc, Box 589, East Lansing, Mich.

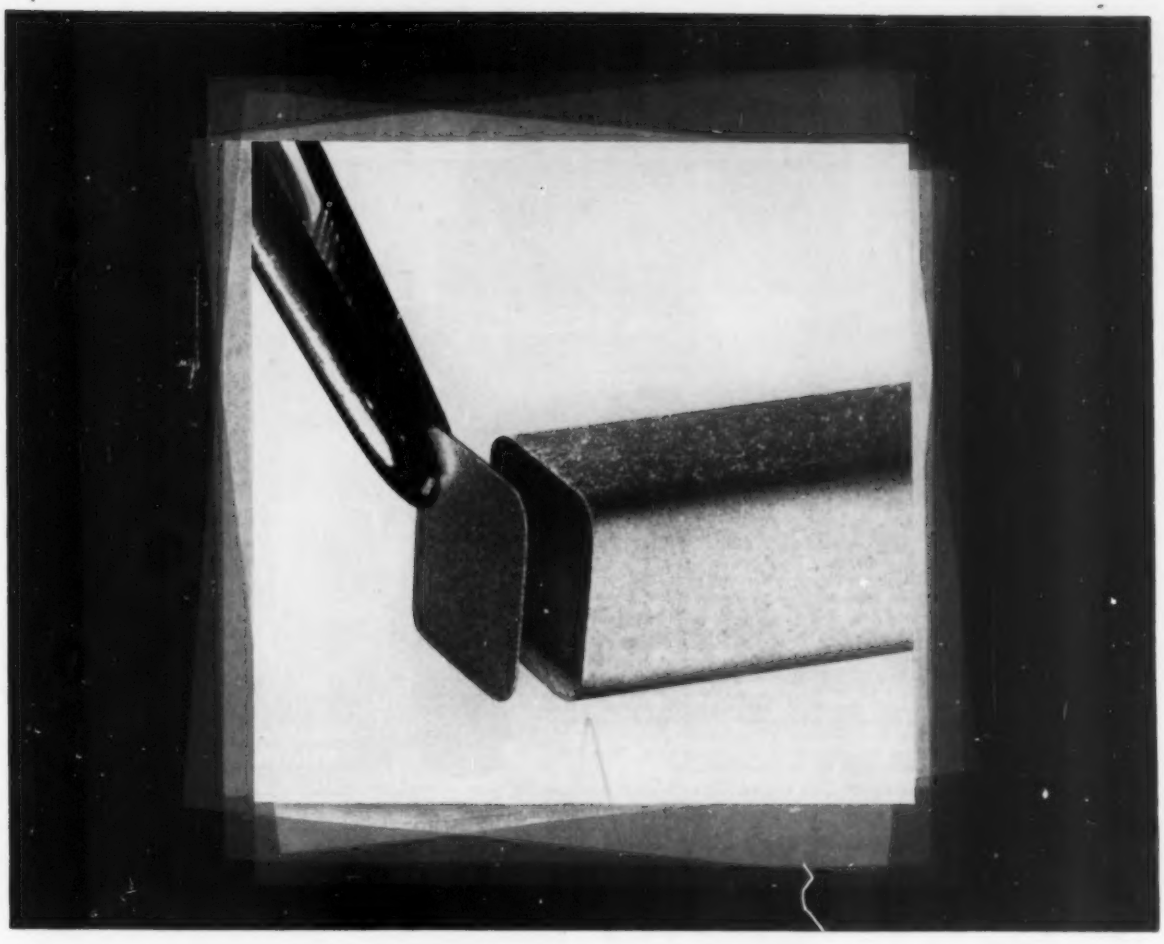
GRAY IRON CASTINGS—1959 directory and buyers' guide, 75 pp. Includes alphabetical and graphical list of members and buying guide to 140 classes of the most common castings. Gray Iron Founders' Society Inc, National City-East 6th Bldg, Cleveland 14.

HIGH-PRECISION POTENTIOMETERS—Catalog, 28 pp. Specifications, diagrams and general information on single-turn, precision wirewound potentiometers. Please indicate your company affiliation and title. Electronic Sales Div, DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1, NY.

HIGH-SPEED GEAR DRIVES—Bulletin 5904, 24 pp. Covers range of high-speed drives for special test stands, industrial applications. Contains specifications, dimensions, rating tables and installation data. Industrial Products Div, Western Gear Corp, PO Box 126, Belmont, Calif.

PROPOSED STANDARD REVISION—Draft, 32 pp. Copies of the proposed revision of American Standard Machine Tapers, ASA B5.10—1953, are available for criticism and comment. American Society of Mechanical Engineers, 29 W 39th St, New York 18.

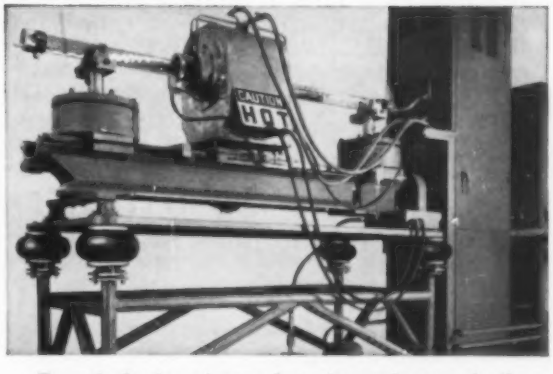
FILTER-ELEMENT ENGINEERING KIT—Consists of assortment of five 1-in. long, ribbon-type filter elements for performance testing and evaluation. Bendix Filter Div, Bendix Aviation Corp, 434 W 12 Mile Rd, Madison Heights, Mich.



How to keep a crystal culture quiet

Firestone Airmount isolates Western Electric's sensitive germanium crystal growing process from vibration.

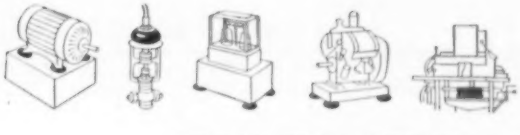
The least little jolt or jar during the cooling stage of the crystal growing process will disturb the orderly realignment of raw polycrystalline germanium molecules. The resulting imperfections reduce the yield of perfect crystals and thereby increase the cost of the tiny transistors for which these crystals are used. Western Electric's installation of the Firestone Airmount suspension isolated the crystal growing machine from external plant excitations and thereby appreciably increased the percentage yield of these high quality crystals. You'll find Firestone Airmount suspensions your answer too, whatever your shock or vibration problem. They can protect your property and increase your product yield. And they offer a big bonus of improved efficiency and morale of your personnel.



Four single air springs and an air supply comprise the easily maintained Firestone Airmount system shown above at work for Western Electric.

FIRESTONE **airmount**

Firestone Industrial Products Co., Noblesville, Indiana



Primitive - metal spinnings

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COMPLETELY FLEXIBLE

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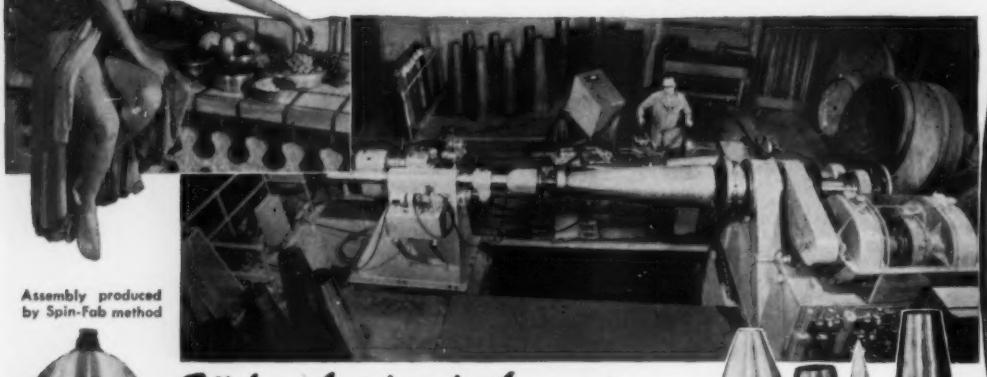

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We've bridged the gap

between primitive metal forming and amazing new techniques that meet the challenge of the space age.

First with the *world's largest horizontal spindle metal spinning lathe*, Phoenix is *first* again with *completely flexible POWERSPINNING* to form diameters, gauges and metals heretofore thought impossible to spin.

Components or assemblies of tough "exotic" metals or everyday type of work can be produced economically with Phoenix *automatic*, *mechanical* and *manual* spinning equipment in conjunction with complete *welding*, *polishing*, *deep drawing* and allied facilities.

Immediate attention given to all inquiries. Visit our plant. See up-to-the minute equipment.

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ALLIED Rubber Tired, Metal Disc Wheels; All Sizes & Kinds!

CONSULT ALLIED ON ALL YOUR SMALL WHEEL NEEDS!

• Build quality—lasting service—sales appeal — customer satisfaction into your product with ALLIED Wheels! Big range of stock sizes and types — or produced to your precise specifications. Priced "right"; with dependable delivery to meet your production schedules

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First choice of the rocket and missile industry...

Three superlative Marsh products are widely used and approved by the aircraft and missile industry:

MARSH Pressure Gauges...
because they combine the most advanced features ever found in pressure, vacuum and compound gauges. There is a Marsh Gauge for every conceivable application.

MARSH Needle Throttling Valves...
because they are guaranteed to give micrometer regulation at HIGH pressures—pressure up to 10,000 psi—and any temperature up to 500° F.

MARSH Dial Thermometers...
because they offer the precision and accuracy a precision industry demands. Most complete line; wide temperature ranges, dial sizes, patterns, finishes.

All Marsh products available with AND threads

MARSH *New catalog covers all details*

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* **Dept. 39, Skokie, Ill.**
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada. Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

Tangents...

Is the Designer His Brother's Keeper?

Somewhere between the guild craftsman of the Middle Ages—who made his products to suit his guild's high standards—and modern mass-production design, the principle of personal responsibility of maker to user has been unceremoniously dumped overboard. We have embraced the principle of caveat emptor—let the buyer beware—more ardently than it has ever been hugged before.

Perhaps it is the production method—in which many men work impersonally on products for nameless buyers—that has caused the loss of personal pride and integrity. Perhaps the loss was inevitable with our mushrooming population. In any case, there are no masterpieces in mass production, and an increasing number of faulty, if not outright dangerous, designs. There are unprotected controls, rough edges, projections, flimsy parts, lethal levers and moving elements—all excused on the basis of cost. There is worship of the great god, Planned Obsolescence, with poor finishes, poor plating, short-life fasteners, non-maintainable assemblies, and generally inadequate protection against weather and wear.

Nowhere has the mass-production, anti-one-hoss-shay philosophy gotten a better foothold than in design of the automobile. We have no wish to beat an industry when it's down, but it represents one-seventh or so of the American economy, so its health affects ours. Its sneeze is certain to bring a number of offers of antihistamines.

Even Uncle Sam is solicitous. To the voices of various independent engineers and college labs, which have pointed out basic design faults, has now been added that of the Bureau of Public Roads, U S Dept of Commerce. The Bureau is concerned about the annual accident toll of 37,000 deaths and 1.3 million injuries, primarily because Uncle Sam is pouring billions into new highways. The Bureau justifies its proposed interference in the name of traffic safety.

There are of course a number of problems that no designer can correct, and only interstate cooperation can: driver inexperience, fatigue, drunkenness, dope, thousands of miles of old and poorly crossinged highways, ease of getting driver's licenses, differences in markings and safety requirements, old vehicles improperly maintained. But, despite emphasis on "safety" in recent designs, the department lists many hazards newly created as old ones are eliminated.

For example, the new low silhouette lowers center of gravity and improves stability and riding qualities on curves, but the 14-in. wheels reduce the flow of cooling air around brake drums and lessen their effectiveness. (And rear vision is seriously affected.) Again, the new wrap-around windshields increase the driver's field of of vision, but wipers do not clean end and central areas in bad weather, permitting blind spots as large or larger than those of flat windshields in critical-vision periods. Then there are projectile-like elements of bumpers and bumper guards, projecting hood and fender ornaments and door handles, and grids that present needless hazards to pedestrians. And tail fins that cut the driver's rear vision, instruments and controls in bewildering and unreadable combinations, multiple rear lights that confuse following traffic (particularly on turn signals), lowering of rear lights that cuts visibility over rises, truck rear lights too dim to be seen until too late.

Surprisingly, the report points out that high speeds (within reason), and high horsepowers are not danger factors. Safest driving speeds are 45 to 70 mph (varying of course with specific conditions). Cars with less than 110 hp had more accidents than higher-powered cars. Automobiles under three years old had fewer accidents than older ones (those over 10 years old were involved in 2½ times as many accidents as new cars).

There is another aspect to the problem, too. Figures on fuel consumption indicate that autos burn eight times as much fuel as central power stations, yet we are much more concerned over nuclear central stations than we are over smog. Up to now, all efforts have been concentrated on catalytic afterburners to knock out the 20% of fuel discharged unburned

(Continued on page 135)

Save On Speed Reduction Costs

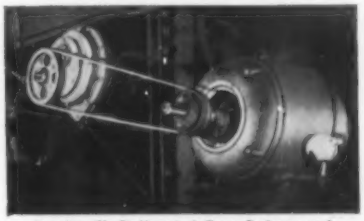
WITH A Lovejoy

Shaft Mounted GEAR REDUCER

COSTS LESS THAN OTHER SHAFT MOUNTED REDUCERS

- Eliminate supporting structures and shaft couplings required by conventional reducers.
- End alignment, simplify belt tensioning problems.
- Save space in any drive arrangement . . . mount vertically or at any angle.
- Install easily on new or old equipment.

Eighteen stock models: 8 to 425 rpm.; fractional to 120 hp.; 4.5:1 (single reduction), 14.7:1 (double reduction) nominal ratios.



Lovejoy Shaft Mounted Gear Reducer and Lovejoy Variable Speed Pulley provide an efficient, compact combination for driving a battery of drying vats. Simple adjustment of rod and turnbuckle maintains proper belt tension.

Request prices and Catalog R-58.

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YOU NAME IT!
... we have them all!

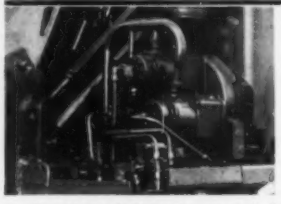
Because we are America's OLDEST Webbing manufacturer, we naturally have the biggest line of Standard Webbings in the country. From dainty little nylon straps for milady's footwear to rugged cargo slings, we carry hundreds of sizes, widths, weights, plain colors and fancy patterns. This tremendous assortment includes cotton, nylon, dynel, dacron, jute, combed peeler mercerized and high tensile webbings. 80% of our STANDARD line would be considered "SPECIALS" by other manufacturers and sold to you from the "SPECIAL" price list. That's why, no matter what use you have for webbing, you can very likely save money here. Let us give you the facts.

***Send for* SAMPLES and PRICES**
Tell us how much webbing you use annually and if possible send a sample for us to match.

BUFFALO WEAVING AND BELTING CO., INC.
206 CHANDLER STREET BUFFALO 7, NEW YORK

We also manufacture a complete line of WOVEN COTTON CONVEYOR BELTS and PURE SHEET RUBBER

A FUNK TRANSMISSION MADE THE DIFFERENCE HERE...



On this Bucyrus-Erie Hydrocrane, a FUNK-designed transmission drives three hydraulic pumps at the same time.

Placed between the engine and the pumps, FUNK's compactly-built transmission saves space by taking only a fraction of the room needed for chains and belts. Saves on cost, too. Requires less service and is much safer.

Another example of how FUNK MODULAR POWER UNITS can be combined in an unlimited number of arrangements — *without* expensive engineering costs.

Let FUNK solve *your* power transmission problem.

FUNK MFG. CO. Box 577-D Coffeyville, Kan.

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IMPORTANT NEW "TOOL" for Surface Inspection and Control

The
MICROCORDER

The Microcorder draws magnified surface roughness profiles that show (1) *peak-to-peak spacing* and *peak-to-valley height* of roughness irregularities and (2) *width* and *depth* of pits, scratches, chatter marks and surface porosity. It is simple to operate, and is designed for use in shop or lab — on metals, paper, plastics, etc. — for any length of trace up to 2¾" on ID's, OD's and flats.

FREE BULLETIN LT138 gives specs. Write —

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MICROMETRICAL MANUFACTURING COMPANY
345 S. MAIN ST. ANN ARBOR 5, MICHIGAN

CIRCLE 173 READER SERVICE CARD

CIRCLE 171 READER SERVICE CARD

from auto exhausts. What of the fact that higher-horsepower, better-performance engines run most of the time at far under full-load capacity? And what of the automatic choke and automatic transmission, with the losses they introduce? The shift to smaller cars is tending to bring back the gear shift, the hand choke, engine-speed indicator and overdrive, but most of us will still probably prefer big cars because of our long vacation and weekend drives. Perhaps designers should think about a low-cost semi-diesel and a more efficient transmission as a practical solution to both the smog and some economy problems.

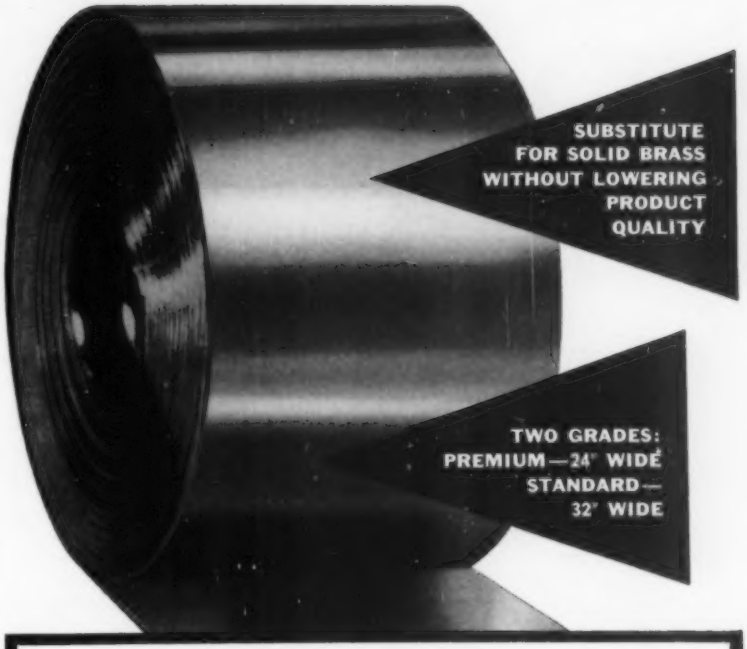
These difficulties affect the auto designer directly, but similar ones apply in suitable degree to other designers as well. What of the machine-tool designs on which safety and maintenance changes were practically forced by the automotive industry through JIC? Or of the impending ones suggested by current research in high-speed machining and in competing metal-removal processes? Or of the greater flexibility of foreign models?

Our founding fathers wisely based their plans on the basic principle that a man's home is his castle. But the automobile is not stationary; its mobility makes it a potential weapon, so the castle theory does not really govern. Perhaps Federal policing could regulate this domestic weapons race.

As always in a civilized community, people either police themselves, or it is done by regulation. The designer, as well as the common man, *must* be his brother's keeper, or be stamped with the mark of Cain. –EJT

"Hendricks, your plans for a new type of refrigerator are great. But what family of four can afford to stock a thousand pounds of meat . . . ?"

NEW PRE-FINISHED BRASS-STEEL SAVES 25% OR MORE ON MATERIAL COSTS



Combines the Decorative Properties of Brass With the Economy of Steel

Where the only BRASS you *need* is the brass you *see*, save 25 percent or more on material costs, reduce production steps with brass-plated steel. This way, the only BRASS you pay for is the substantial brass coating you *really need*. Big 32" wide coils — the widest ever made — in Standard grade, for utility or decorative uses; 24" wide in Premium grade, our finest quality — an economical substitute for pure brass for many applications. Both grades are sealed with BAKEKOTE, a baked resin film. Mar-Not protective coating protects the pre-finished surface during fabrication. Big 24" and 32" wide coils and sheets — bright and satin finishes and crimps. Also stripes in sheets, only.

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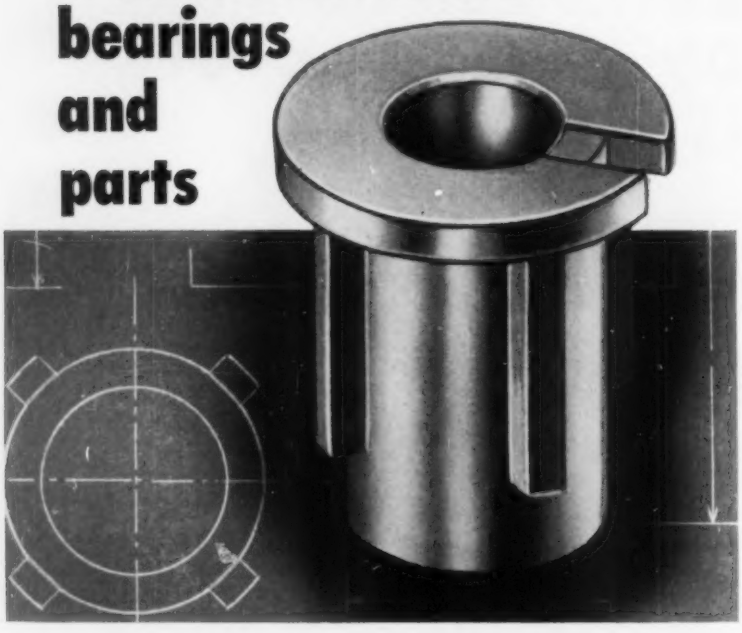
Bunting makes the "almost impossible" bearings and parts



The photograph shows a sintered bronze bearing used in an exceedingly popular home laundry drier. It offers several unusual features, some of which you may find useful in designs you are considering as sintered parts. In the first place because the splines on the O.D. of the bearing abut the back of the bearing flange, this is a part which would be almost impossible to produce by machining but can readily be produced by powder metallurgy.

Second, the splines do not extend the full length of the bearing but the density of the splines must be the same as the remainder of the bearing. This requires intricate and unusual tooling and understanding of the problem which is one of the reasons why this manufacturer put his design in the hands of Bunting.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze, sintered metals or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

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Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

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BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

DESIGN ABSTRACTS

Determining Weld Size

A five-step method for determining required weld dimensions for various types of welds and applications is presented. Suggestions are based on American Welding Society definitions and stress allowances.

"Practical Approach to Determine Weld Size," O W Blodgett, Lincoln Electric Co, AWS paper 12-C, 33 W 39 St, New York 18.

Effect of High Temperature on Friction

Experiments conducted to provide friction temperature curves for lubrication systems dependent on chemical reaction films are reported. Both lubricated and unlubricated apparatus were used and the effects of such additives as sulfur, chlorine, phosphorus noted.

"Effect of High Temperature on Friction and Wear," Douglas Godfrey, California Research Corp. Paper No. VI-23 presented at Fifth World Petroleum Congress, May 30-June 5, 527 Madison Ave, New York 22.

Static Electricity in Fuels

Static electricity is produced in liquid hydrocarbons when there is relative motion of the hydrocarbon and a second phase (solid, liquid or gas). Conditions under which electrostatic charge can reach hazardous levels are described, methods of measuring charge and of minimizing the dangers are discussed.

"Engineering and Theoretical Studies of Static Electricity in Fuels," Rogers and Schleckser, Esso Research & Engineering Co. Paper No. VII-10, Fifth World Petroleum Congress, May 30-June 5, 527 Madison Ave, New York 22.

Rigid Thermoplastics

Compares rigid polyvinyl chloride, toughened polystyrene, rigid polyethylene.

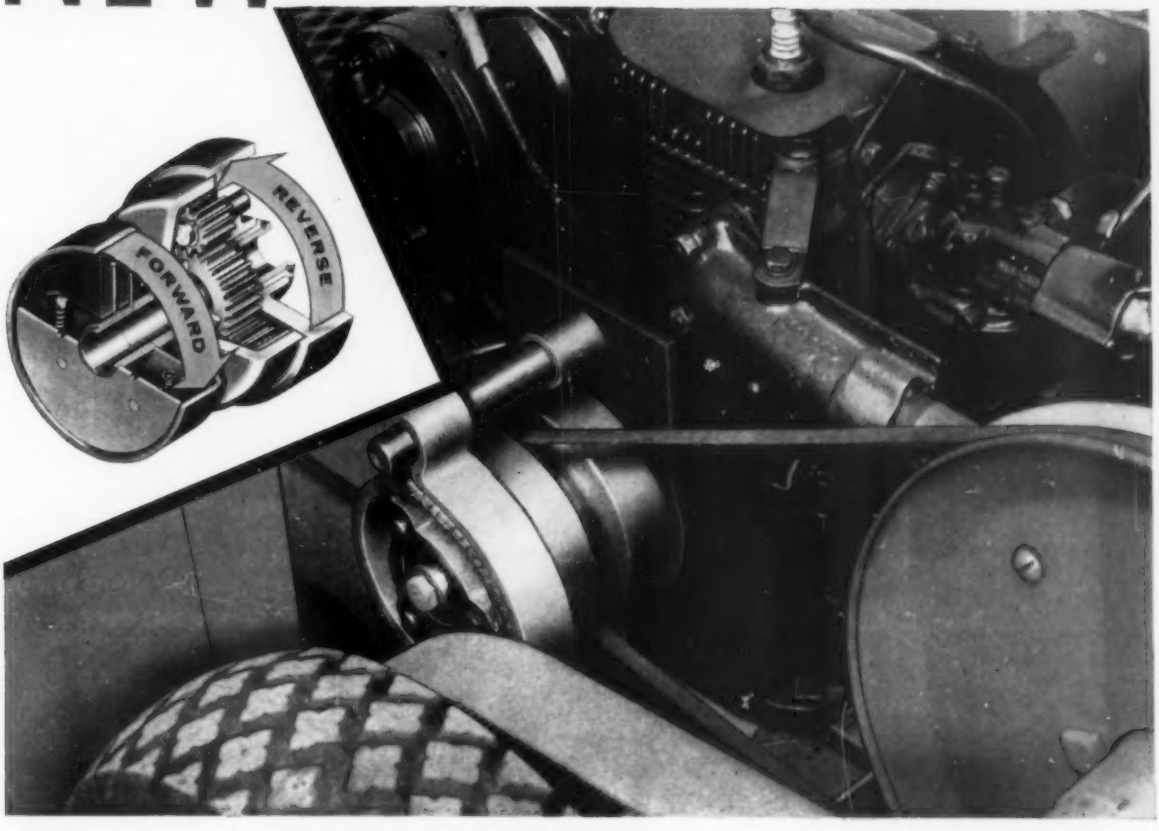
"How to Select Rigid Thermoplastics," D A Lannon, British Resin Products, Ltd. Engineering Materials and Design, May 1959, Drury House, Russell St, London W C 2, England.

Two on Reinforced Plastics

A recent regional technical conference sponsored by the North Texas Section of the Society of Plastics Engineer (65 Prospect St, Stamford, Conn) included a paper on the structural characteristics of reinforced plas-

(Continued on page 139)

NEW reversible transmission for small gasoline engines



Gives automatic no-load starts at best engine speed

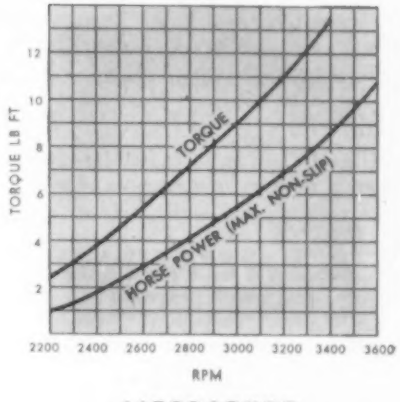
If your product is powered by a small gasoline engine (1-1/2 to 5 hp) you can make it more versatile, *and* add important new sales features by installing the new Fairbanks-Morse packaged, reversible transmission.

For automatic no-load starting at best engine speed and smooth reverse without gear shifting, the F-M transmission has an automatic centrifugal forward clutch and planetary reverse gearing. The entire package (3-7/8" x 4-5/16") mounts directly to engine or motor shaft.

Operation is simple — increasing engine speed causes the automatic clutch to engage smoothly as the load is accelerated from a dead stop to full operating speed. The remainder of the transmission, attached to the clutch drum assembly, rotates in forward. For reverse, a simple mechanical brake is applied, stopping brake drum rotation. A sun gear attached to the engine shaft continues to rotate, reversing a ring gear through three planetary pinions. Releasing the brake returns drive to forward.

In addition to automatic forward and reverse, this unique clutch-transmission combination offers such additional advantages as simple, sturdy construction; overload protection; high torque (see torque speed curves, right); and engagement speeds adjustable over a range of 1150 to 2700 rpm.

TORQUE — SPEED CURVES



LITERATURE

For more detailed information on this new packaged transmission send for the free four-page illustrated bulletin F-M 296. This brochure includes full dimensional data, typical installations, and application data for all popular small gasoline engines, plus electric motors. Write Fairbanks, Morse & Co., Magneto Division, Beloit, Wisconsin.

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Electrical faults in appliances, TV sets, radios, motors and other electrical devices frequently lead to fires—and these fires lead to complete destruction of the equipment, sometimes extensive damage to the facilities surrounding it. Taylor FIREBAN 321 is designed to retard fire. Self-extinguishing in only 3 seconds—it is an effective barrier against the spread of flame. In addition, this flame-retardant laminated plastic has excellent moisture resistance, excellent electrical resistance after exposure to high humidity, and good mechanical properties; also offers low dielectric losses. These properties help prevent the electrical faults that lead to fires. Write TAYLOR FIBRE CO., Norristown 39, Pa., for complete details.

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"JANETTE is a precision manufacturer of quality products. They make gear motors to meet the most exacting specifications. They handle our quantity business as well as our small orders without sacrificing individual attention. Operating costs are lower because JANETTE Gear Motors give longer life."

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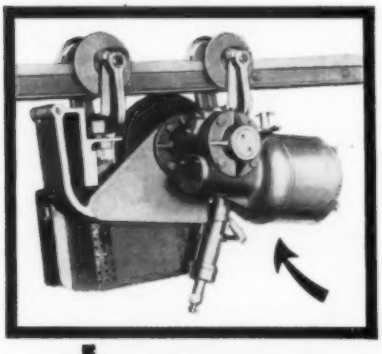

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tics and another on materials and processes applicable to their fabrication. "Structural Characteristics and Analysis of Reinforced Plastic Parts," R W Matlock, Summit Industries Inc, contains a discussion of useful properties of an idealized structural material. An analysis of how well reinforced plastics compare with such a model is then made. Out of this is derived a listing of the laminated material's most useful characteristics.

"Materials and Processes for Fabricating Reinforced Plastics Parts," Benjamin Sokol, Republic Aviation Corp, contains an item-by-item description of available resins, reinforcements and manufacturing techniques. Tabular data on strength levels and costs is also included.

Level-control by Electrical Capacity Measuring

Level-control system developed for petroleum refinery uses a transmitter near point of measurement and recording equipment in convenient location. Has been used for hot and cold liquids, granular materials, corrosive fluids, as well as for certain types of stream analysis.

"Versatile Capacity Measuring System for Level Control and Stream Analysis," Shawhan, Bachofer, Lerner and Wright, Sun Oil Co. Midyear Meeting, May 27-29, American Petroleum Institute, 50 W 50th St, New York 20.

Solutions of the Metallurgist

Development of theories concerning solutions of metals, salts and slags from the time these chemical mixtures were first seriously studied to the present is traced. The mathematical models from which thermodynamic properties can be derived are considered and limitations discussed.

"The Solutions of the Metallurgist—Retrospect and Prospect," F D Richardson. Imperial College, London, England. Presented at the AIME International Symposium on Physical Chemistry of Process Metallurgy, April 27-May 1. AIME, 29 W 39th St, New York 18.

Magnesium Alloys

Properties and other factors affecting design of magnesium parts made by various methods are discussed.

"Designing with Magnesium Alloys," K G Bailey, Magnesium Elektron Ltd. Engineering Materials and Design, Apr '59, Drury House, Russell St, London W C 2, England.

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in Kel-F, Viton-A, Vyram, Polyurethane, and other unusual elastomeric materials having excellent resistance to many petroleum oils, synthetic lubricants, fuels, phosphate and silicate ester fluids—in a temperature range of —40° to +500° F.

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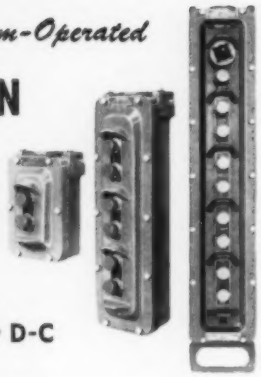

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A-C or D-C

● The Euclid Electric & Mfg. Co. (Madison, Ohio) has added a complete new line of Pendant Push-Button Stations for all applications that necessitate NEMA Types 7 and 9 enclosures to meet hazardous-location requirements. Designed for heavy-duty applications, these cam-operated Stations are rated 600 volts, a-c or d-c. They are available from one to five speed-points in each direction for a total of eight circuits to provide for practically an unlimited number of different sequences of operation.

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Extra features include heavy-duty, control-circuit toggle disconnects, pilot lights, selector switches, and maintained-type contacts.

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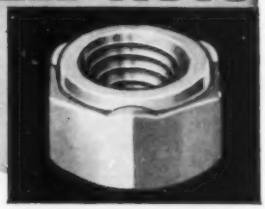

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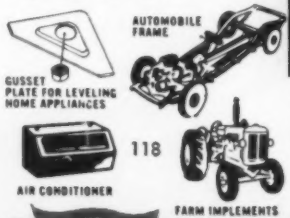
Gripco Countersunk Weld Nut eliminates time-wasting retapping of nuts after welding. Exclusive countersunk nut bottom eliminates fouling of threads by weld spatter. No time wasting false starts, no cleaning of damaged threads, nut ready to receive bolt immediately.



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NEW BOOKS

Metals at High Temperatures

Metals for Supersonic Aircraft and Missiles

American Society for Metals, Cleveland. 6½ x 9, 432 pp. $7.50.

The topic, problems caused by aerodynamic heating of metal structures, is narrow. Yet, because aircraft and missile design so often leads the field, this book provides much needed data for elevated temperature design. It also discusses kinetics of oxidation, protective coatings, cermets and presents current trends in high-temperature design.

Behavior of Metals at Elevated Temperatures

Philosophical Library Inc, 15 E 40th St, New York 16. 5¾ x 9, 122 pp. $6.

A refresher course for metallurgists, this book discusses theoretical effects of high temperature on physical and mechanical properties. It also gives principles to follow for developing high-temperature alloys.

Two different publishing philosophies are reflected in these books. One book attempts to be more timely and to give up-to-date information on materials and design trends (though limited to the aircraft field). The second places more emphasis on the fundamentals of how metals behave at high temperatures.

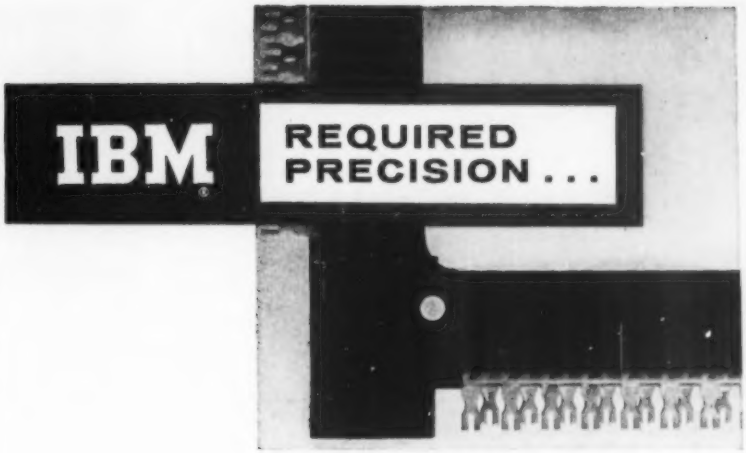
Both consist of papers by competent authors distinguished in their fields. The former contains more practical and immediately useful material in practically all categories. However, it concerns itself with a highly specialized topic.

Simplified Problems in Strength of Materials and Structural Design

E VIERTELS. Arco Publishing Co Inc, 480 Lexington Ave, New York 17. 9 x 6, 636 pp. $5.

This text provides an easy, practical and comprehensive review of the mechanics of engineering, covering most subjects that may be found in any college engineering textbook on structural problems and design. Enough

(Continued on page 143)



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This 12″ x 15″ phenolic "Memory Frame" for IBM was plunger molded in one piece with 440 wire terminal inserts. Later, strung with copper wire containing a series of 8,000 ferrite magnetic cores, these frames are stacked one atop the other and wired together in conjunction with other components to give IBM's 705 Data Processing System a "memory" capacity of 40,000 characters.

Dimensionally stable frames that would withstand dip soldering at extra high temperatures were a necessity. They could not bow or crack, nor could there be more than minimum after-shrinkage or expansion once assembly was completed.

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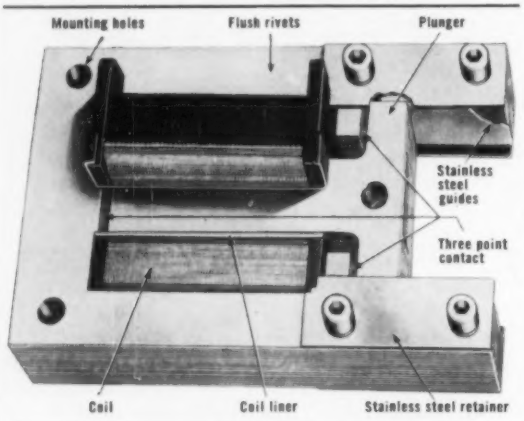

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New lightweight, space-saving resistors permit substantial efficiencies and economies in aircraft and missile electronic apparatus. Units are mounted in direct contact with inner surface of chassis or case so that 25% to 40% of heat generated is emitted to atmosphere. Derating curves are available.

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40 Watts	7/32 x 1 5/16 x 4	.027 lbs. ea.
80 Watts	7/32 x 1 5/16 x 6	.040 lbs. ea.
120 Watts	7/32 x 1 5/16 x 8	.053 lbs. ea.
160 Watts	7/32 x 1 5/16 x 10	.067 lbs. ea.
200 Watts	7/32 x 1 5/16 x 12	.080 lbs. ea.

Insulation is silicone rubber—operable continuously at 450° F.
Mounting metal—Alclad aluminum.
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Special washers permit bolt or rivet mounting. Adhesive supplied provides good thermal transfer from resistor to mounting wall.

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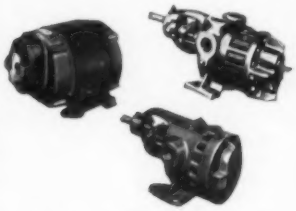

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theory is given to make sure that the reader has a thorough understanding of the basic principles involved.

The text should also be of help to the professional engineer as a reference source and as a refresher on practical problems that arise.

Engineering Manual: Practical Reference of Data and Methods

Edited by JOHN H. PERRY and ROBERT H PERRY. McGraw-Hill Book Co, 330 West 42nd St, New York 36. 5 x 7½, 680 pp. $9.50.

A useful supplement to an engineer's library, the manual brings together in one volume the most commonly used data and methods in the architectural, chemical, civil, electrical, mechanical, and nuclear engineering fields. General mathematics, mathematical tables, and physical and chemical data common to the major engineering sciences are given in three separate sections prefacing the manual. Specialized tables, graphs, formulas and other aids are presented within the appropriate engineering sections.

Research on Flammability of Aircraft Hydraulic Fluids

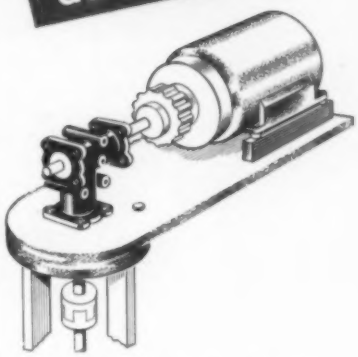
ZABETAKIS, IMHOF and LANG. PB 131193 (WADC Technical Report 57-151) Bureau of Mines, US Dept of the Interior. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 29 pp. $1.

The results of spontaneous ignition temperature tests conducted on JP-4 fuel and seven hydraulic fluids in air while in contact with seven sur-

(Continued on page 145)

"The starting salary is low, but you'll be putting in so many hours you won't have a chance to spend money anyway."

ANGLgear® simplifies power package design



Drawing based on photo shows ANGLgear power takeoff on power package for liquid tar pump. ANGLgear's compactness and 4-way mounting simplified design of unit, helped reduce size.

In designing a power package for a portable tar pump used in roofing work, Continental Cleveland Corp., Cleveland, Ohio, needed a simple, compact 90° power takeoff to stand rough service and handle heavy transmission loads.

A Model R-340, 5 hp ANGLgear met these requirements perfectly. Because of its compactness and 4-way mounting feature, it was easily designed into the power train and helped reduce the size of the entire power unit. It also had the necessary stamina to absorb the loads involved in pumping liquid tar to heights up to 90 ft. Completely enclosed, it could not be fouled by the tar.

Perhaps ANGLgear can solve a 90° drive problem for you. Designed for manual or power operation, ANGLgears are available from stock in ⅓, 1, 2¼ and 5 hp ratings, with 2 or 3-way shafting, and 1:1 or 2:1 gearing.

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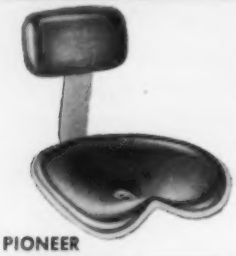
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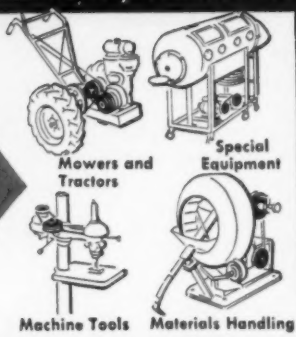

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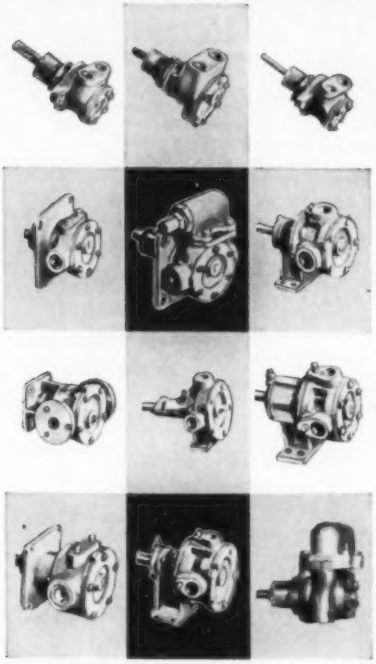

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faces found in aircraft are presented. Tests were conducted at reduced and elevated pressures using both low and high velocity injection techniques. They were conducted between Nov 1, 1956 and Oct 31, 1957. Hydraulic fluids Esso Univis J-43 (Spec MIL-0-5606), MLO 53-446 (General Electric GE 81406), MLO 54-540 (Monsanto OS 45), MLO 54-581, MLO 54-645 (85% Oronite 8200 + 15% Plexol), MLO 54-856 (Hollingshead 72073C) and MLO 8200 (Oronite 8200) were tested while in contact with heated aluminum, beryllium-copper, copper, magnesium, pyrex glass, stainless steel and titanium surfaces. In addition, the flash and fire points of these fluids were determined in a standard ASTM apparatus.

Materials for Rockets and Missiles

FRANK AND ZIMMERMAN. The Macmillan Co, 60 Fifth Ave, New York 11. 5 x 7, 124 pp. $4.50.

This book has grown out of the urgent need for a single source of engineering data on lightweight, high-temperature materials that are now available for rockets and missiles. The fact that such data have not previously been readily accessible has resulted, all too frequently, in rockets being designed without full advantage being taken of current materials.

The authors of this slim volume seek to present typical engineering data on existing metal and ceramic materials and to preview materials which are expected to become available during the next few years. Their book will provide the engineer who is not familiar with materials with a broad understanding of ceramics and high-temperature metallurgy. Unlike many other books in the field, this volume aims to give a cross-section of all materials available, with recommendations for each use.

The authors point out the difficulty of keeping abreast of all high-temperature materials, since processing techniques, compositions and fabricating methods are constantly being improved. A good example not covered in the book is Rene-41, a new and promising nickel-base alloy developed by the authors' own company, General Electric. In recognition of such ironies, perhaps, the authors provide

(Continued on page 147)

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The most revolutionary Flexible Coupling Design Development in a Century!

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New Miniature Coupling

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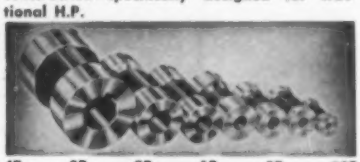

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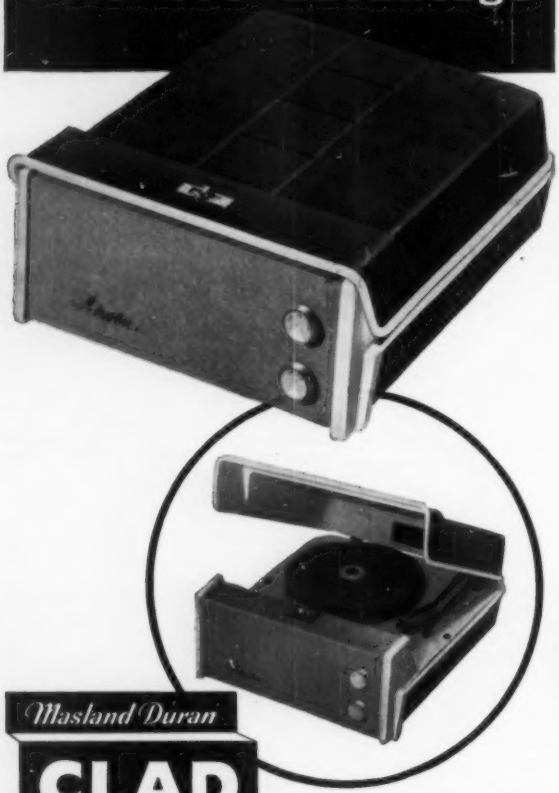

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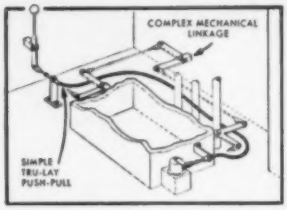

Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

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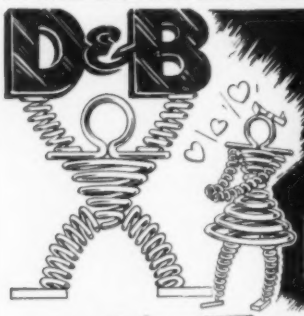

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a framework in which to incorporate new developments as they occur. They set forth outstanding examples of each type of material, thus giving a basis for classifying new materials. Materials are compared according to their chemistries and selected physical properties. New material fabrication processes, including high-temperature brazing, chipless production and unconventional machining techniques, are also covered.

Machine Design Problems

D J MYATT. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 8½ x 11, 186 pp. $5.50.

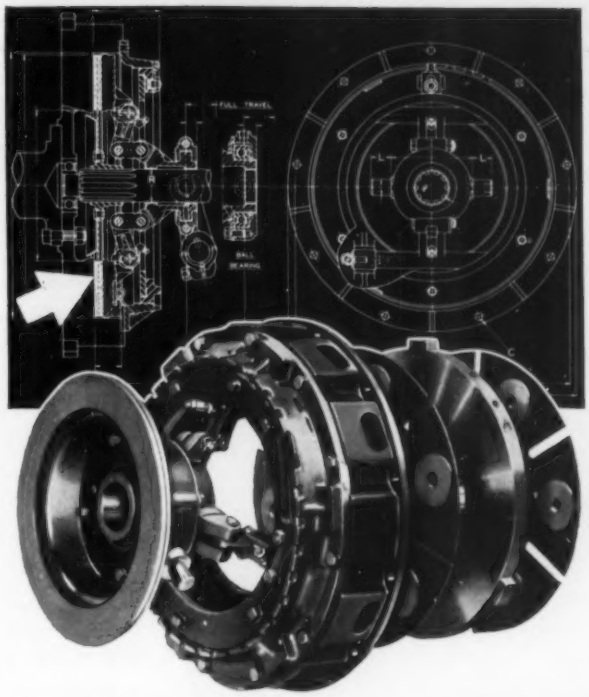
The machine designer is given an opportunity in this workbook to apply the principles of mechanics, kinematics, mechanics of materials, metallurgy and manufacturing methods to the design of machine elements and machines.

Throughout these problems, emphasis is placed upon determination of the fundamental behavior underlying action of the part being designed. In addition, much data of a practical nature is called for to encourage the practice of finding and deciding upon reasonable proportions for machine components. The problems on the design of machine elements have been selected so that a variety of approaches to their solution is required.

A second part contains problems that require the complete design of a

(Continued on page 149)

ROCKFORD



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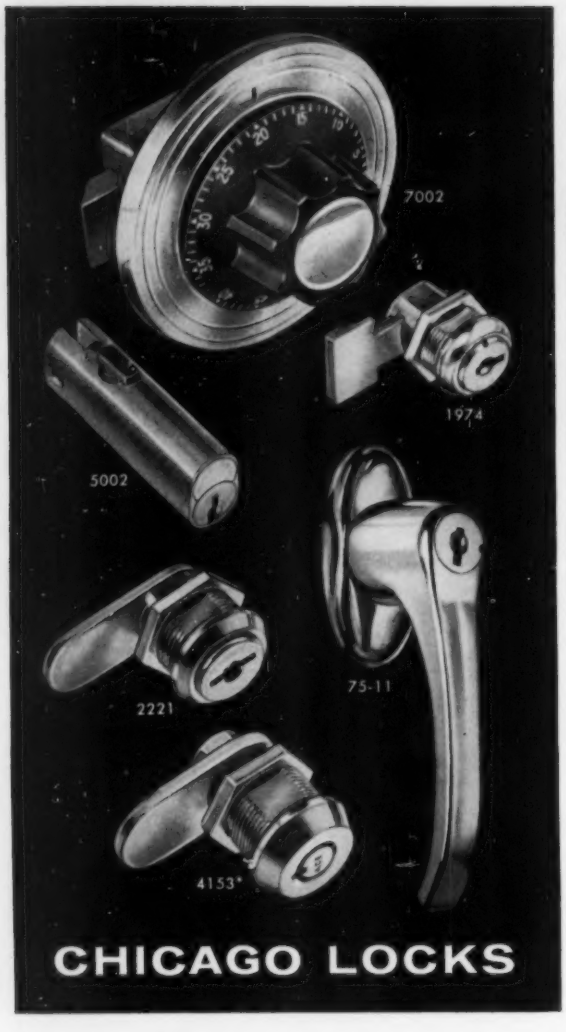
CLUTCHES



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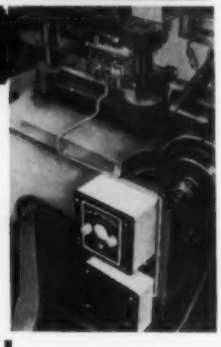

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AT LOW COST!

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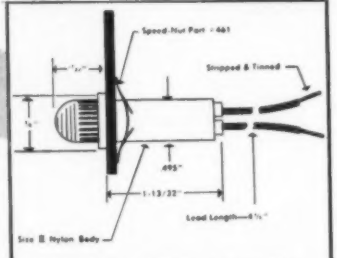

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machine. A number of lists of design data have been compiled and are attached to the problems. These data represent typical values presently being used in initiating engineering designs. Only the information necessary to analyze the fundamental behavior or specify the limits of the parts being designed is included, primarily. In many instances, more complete data, obtained from the manufacturer's catalog or specification, may be required before the design can be considered to be complete.

Other Books of Interest

Acoustic Emission Under Applied Stress.
PB 151215. Schofield, Bareiss and Kyrala. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 34 pp. $1.25.

Mechanical Properties of Metals.
Edited by L W Hu, J Marin. Penn State University, University Park, Penna. 8½ x 11, 294 pp. $8.50.
Proceedings for short course.

Theory of Stability of Motion—AEC-fr-3352.
I G Malkin. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10¼, 456 pp. $4.75.
Translated from a publication of the State Publishing House of Technical-Theoretical Literature, Moscow-Leningrad, 1952. Concerned with investigating the effect of disturbing factors on the motion of a material system.

Various Aspects of Distribution of Fatigue Lives.
PB 151211. E J Gumbel. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 40 pp. $1.25.

Hot Extruded Ductile Cast Iron.
PB 131690. E B Blake, S V Arnold. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10½, 20 pp. 75¢.
Report of an investigation of the extrudability of ductile cast iron.

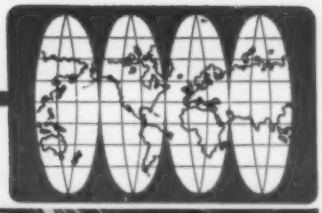
Metallurgical Factors Affecting Tensile Properties of Fe-Al Base Alloys.
PB 131633. W J Buehler, C G Dalrymple. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8 x 10½, 29 pp. $1.

New Instrumentation Requirements for Metal-cutting
Foundation for Instrumentation Education & Research Inc, 335 E 45th St, New York 17. 8½ x 11, 111 pp. $5.
This is the proceedings of the Exploratory Clinic sponsored by the ASTE, FIER and U of Michigan.

Fringe Benefits.
Francis M Wistert. Reinhold Publishing Corp, 430 Park Ave, New York 22. 5 x 7½, 155 pp. $3.75.
Discusses history, cost and economic signifi-
(Continued on page 151)

DAVID BROWN

at work around the world



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cance of known fringe benefits of regional, industrial or national importance with forecasts of their further development.

Semiconductor Abstracts: Vol. IV—1956.
Edited by E Paskell. John Wiley & Sons Inc, 440 Fourth Ave, New York 16. 8½ x 11, 456 pp. $12.

Filler Metals for Joining.
O T Barnett. Reinhold Publishing Corp, 430 Park Ave, New York 22. 6 x 9¼, 244 pp. $7.

Welding of Plastics.
J A Neumann, F J Bockhoff. Reinhold Publishing Corp, 430 Park Ave, New York 22. 6 x 9¼, 279 pp. $7.25.

Industrial Leadership.
C Weber, J W Karnes Jr. Chilton Co, 56 and Chestnut Sts, Philadelphia 39. 5¾ x 8¾, 226 pp. $5.

Simple Bend Test to Measure Uniformity of Ductility in Sheet Metal.
PB 131947. S V Arnold. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 6 pp. 50¢.

Current Reprints

While the supply lasts, single copies of the following reprints are obtainable by using the Reader Service Card.

Nylon's Tough New Rival
Design data on a new plastic-rubber blend costing half as much as nylon. June 8
Circle E 86

Dwell Position of Three-Gear Drives
New equations aid in design of this intermittent drive. June 8 *Circle E 85*

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Circle E 84

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Gasket behavior with different flange metals and fluctuating temperatures. May 25
Circle E 83

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Circle E 82

Gear Tolerances
Workable approach to new precision standards. May 25
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(Continued on page 153)

RMB

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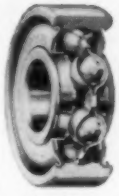

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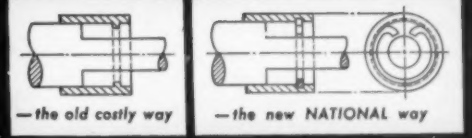

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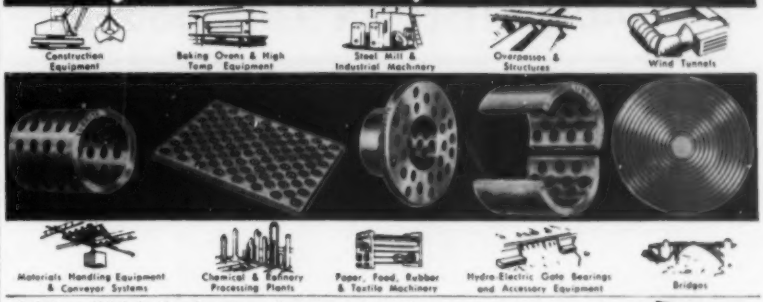
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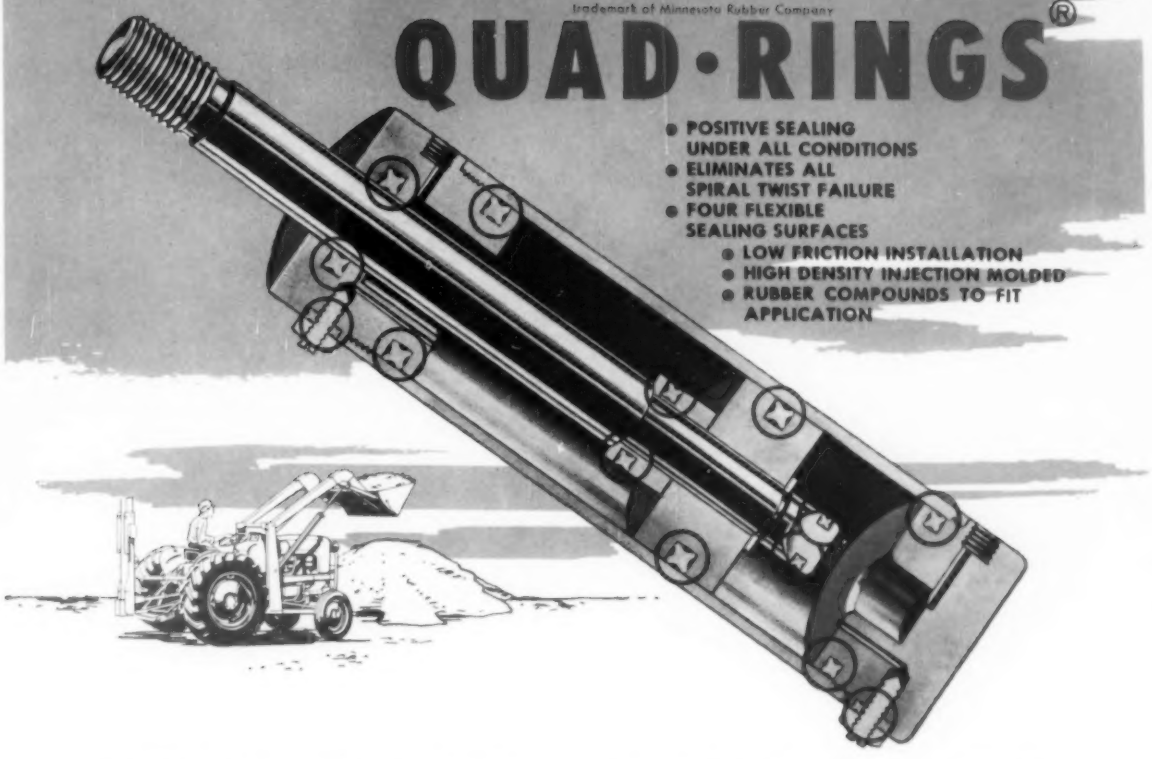

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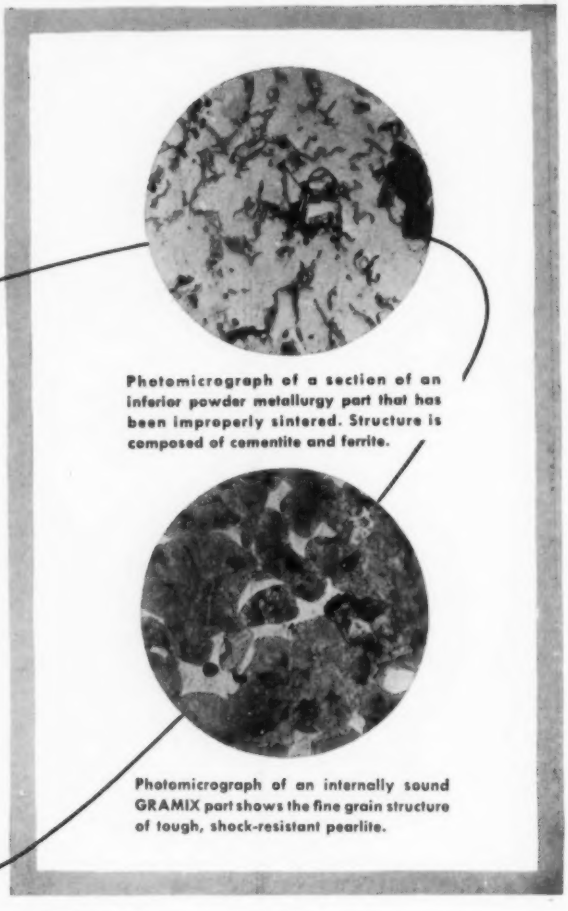

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